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## VOCAL AND VERBAL SYNDROMES

### THEIR RHINOLARYNGOLOGIC SIGNIFICANCE

JAMES SONNETT GREENE, M.D.

Medical Director, National Hospital for Speech Disorders

NEW YORK

I have often wondered how many laryngologists realize the value of alterations in the voice as a preliminary diagnostic aid in conditions of the throat—how many, in making a diagnosis, use their auditory as well as their visual sense. I believe that the laryngologist—if he possesses a trained ear—should be well on the road to a diagnosis as soon as he hears his patient speak, because I have found that just as there are characteristic physical alterations peculiar to certain pathologic conditions of the larynx, there are also characteristic *vocal* alterations.

Before developing this thesis, I wish to recall some of the basic facts of voice and speech production. Voice, as distinguished from speech, is simply the production of sound through the medium of expired air. A normal voice has certain definite characteristics: a pitch appropriate to age and sex, adequate volume, tonal clarity, resonance, rhythm and a direct attack.

Speech is articulated voice and may be described as a systematic grouping of purposive organized sounds conveying complex meaning. The normal sounds of speech require not only the vocal cords and pulmonary apparatus but the oral and nasal cavities and the lips, tongue and teeth. The waves set up by the vibrations of the vocal cords are modified by these structures and thus differentiated into the various sounds of speech. Further, these structures are under the control of the central nervous system, and ideas arising there are given expression in speech through association fibers, the speech centers and the centers controlling the peripheral muscles involved. The sense of hearing also is highly important for the effective performance of speech, and the normal and uninterrupted flow of speech depends on the proper functioning and coordination of all of these structures, central and peripheral.

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This paper and those that follow were read as part of a Symposium on Vocal Defects at the Forty-Fifth Annual Meeting of the American Laryngological, Rhinological and Otological Society, Inc., Chicago, May 11, 1939.

Disturbances of the speech and language functions constitute much too complicated a field to be discussed here, however, although they, too, have their laryngologic significance. Here only those vocal alterations *will be considered that arise from laryngeal disease.*

The larynx, rather incorrectly, is generally spoken of as the organ of voice. In reality, however, it is part of the pulmonary system, and its respiratory function is primary. The abductor muscles open the glottis and allow the necessary space for breathing, while the adductor muscles bring the cords together for the secondary function of phonation.

Phonation, as the term is commonly used, means the setting in motion by the vocal cords of a column of expired air. For normal phonation the cords must approximate, draw tense and vibrate. Sounds of the pitch desired and with a certain amount of overtones are thus produced by the vocal cords. As I said, these sounds are amplified and selected in the pharynx, nose and mouth.

A minor pathologic change can cause faulty functioning of the vocal cords and interfere markedly with voice production. The most common vocal alteration arising from faulty approximation of the cords is hoarseness (trachyphonia). The common symptom of hoarseness is so generally encountered by the laryngologist that too often he perfunctorily dismisses it, failing to appreciate that it may be as important a diagnostic aid as his laryngoscopic observations.

However, the fact that vocal alterations, such as hoarseness or even aphonia, are symptoms of laryngeal disease does not mean that either larynx or cords are necessary for voice production. A much simpler organ would have been sufficient for man's vocal needs. The cat, for example, has no vocal cords but every one knows that it has a voice which—much to the nocturnal discomfort of its hearers—demonstrates a wide range of discordance.

Man also can produce a fairly normal voice without vocal cords, as the postoperative voice in the following case of keratosis demonstrates:

CASE 1.—D. S., a man aged 43, complained of hoarseness of over two years' duration. Direct laryngoscopic examination by Dr. David Jones, of the Manhattan Eye, Ear and Throat Hospital, showed an irregular mass involving both cords. After biopsy of a number of specimens the condition was diagnosed as hyperkeratotic papilloma. The left cord and subsequently the right one were removed, so that now the patient has no cords whatsoever, with the exception of some fibrous tissue on the *left side*.

(A recording of the patient's voice and speech was played.)

This patient's voice is rough, gruff and coarse—a muffled voice lacking in intensity and overtones. However, it is evident that the patient has no difficulty in speaking and finds his voice adequate in spite of the extensive destruction of tissue and the impairment of function. In fact, the larynx is more efficient mechanically than in other conditions in which destruction of tissue is often not so extensive.

## LARYNGEAL STENOSIS

In chronic laryngeal stenosis voice and speech are often severely affected, even after dilation of the larynx has been successful. In such cases the acquisition of adequate voice and speech may be greatly enhanced by the introduction of speech and voice training along with the dilatory treatments. The following case illustrates this twofold therapy:

CASE 2.—Marie S., aged 11 years, had emergency tracheotomy for diphtheria when 20 months old. About a year previous to the time of writing, at the age of 10 years, she was brought to the bronchoscopic clinic of the Manhattan Eye, Ear and Throat Hospital for decannulation. Laryngoscopic examination at that time showed the larynx completely closed. She has been under a therapeutic regimen consisting of dilation with sounds and the use of core molds ever since.

(A recording of the patient's voice and speech made six months after dilatory treatments were instituted was played.)

At the time of the recording her voice was hardly recognizable as a human voice at all. It was a distinctly unpleasant, scraping, quacking, tracheal voice, with a pronounced inspirational stridor. In short, she sounded exactly like Donald Duck.

Speech training was instituted in conjunction with the dilatory therapy at that time. During the next three months she attended the clinic of the National Hospital for Speech Disorders twice weekly, receiving one hour's speech therapy at each visit. At the end of that period a second recording was made. The improvement noted at that time was remarkable.

(A recording of the patient's voice and speech made after three months' treatment was played.)

Her voice may now be described as adequate, although still far from normal. Tonal clarity, resonance and rhythm are now present, and the inspirational stridor is gone. Her speech is now readily understandable, but the volume is not strong because decannulation has not yet been possible. Self consciousness causes her attack to be weaker than need be, but progress thus far convinces my colleagues and me that continued therapy will produce a voice and manner of speech normal in all respects.

## CANCER

When considering some of the other laryngeal involvements, one finds that in the presence of malignant conditions the laryngologist's auditory sense is especially important, for hoarseness often leads to early recognition and diagnosis of the condition.

In cases of cancer of the larynx, I have noticed a striking similarity of vocal abnormalities, whether the lesion is intrinsic or extrinsic. The next 2 cases illustrate this:

#### INTRINSIC CANCER OF THE LARYNX

CASE 3.—F. E., aged 54, first lost his voice over a year previous to the time of writing. At that time Dr. H. B. Orton recommended that a biopsy be done, but the patient refused, and for eleven months received no therapy whatsoever. He then came to the clinic of the National Hospital for Speech Disorders, complaining of hoarseness.

Examination disclosed an ulceration on the left arytenoid and a thickening of the left ventricle. The patient was referred back to Dr. Orton, who confirmed the tentative diagnosis of cancer. Biopsy of a specimen from the left ventricular band disclosed an intrinsic cancer of the larynx of grade III malignancy. Dr. Orton found the lesion so extensive "that to remove the whole thing by operative procedure was out of the question."

(A recording of the patient's voice and speech was played.)

#### EXTRINSIC CANCER OF THE LARYNX

CASE 4.—M. C., a man aged 65, had a history of hoarseness going back to 1911, at which time he had had some form of operation. His hoarseness had continued "off and on" ever since that time. Dr. Jones stated that a recent roentgen examination had disclosed a tumor of the left side of the mediastinum. Laryngoscopic examination showed marked involvement of the right side of the larynx. Biopsy revealed epidermoid carcinoma, type I. The involvement affected the right vocal chord, the left side of the mediastinum and the apex of the left lung. The condition was considered inoperable, and the patient was sent to a home.

The voices of such patients, although they often differ in other tonal qualities, tend to be characterized by wheezy undertones. In this respect the 2 cases afford striking examples. Analyzing the voices, one finds that they are both toneless, rasping and decidedly tracheal. They are muffled and strained almost to the point of being aphonic and have a peculiar quality which can be readily discerned by the trained ear. Of course, the characteristics are less well defined in the presence of the extrinsic growth but both voices have the same *wheezy undertone* and are decidedly different from the voice associated with benign conditions of the larynx.

#### HEMANGIOMA

The vocal changes associated with a benign condition are decidedly different from those associated with cancer. The following case of hemangioma of the right vocal cord illustrates this:

CASE 5.—H. T., a man aged 26, gave a history of hoarseness of five years' duration.

Examination of the larynx revealed a hemangioma about the size of a small pea on the right vocal cord in the midportion, involving the approximating surfaces. The hemangioma was removed, and the patient's voice is now perfectly clear.

(A recording of the patient's voice and speech before the removal of the hemangioma was played.)

The voice associated with a benign tumor does not have the wheezy quality that characterizes that in cases of a malignant growth. Although this voice is flat and raucous, with a coarse, heavy vibrato and little intonation, it does have intensity, which the voices in the cases of malignant growth lack.

#### TUBERCULOSIS

Inflammatory conditions of the larynx, as every one knows, are the most frequent cause of hoarseness. Acute and chronic laryngitis are the commonest of these conditions. Tuberculosis of the larynx is the next in order of prevalence. The most frequent site of the tuberculous lesion in the larynx is the posterior commissure, and in the following case this typical involvement was present.

CASE 6.—W. M., a man aged 26, when first seen at Mt. Sinai Hospital, complained of hoarseness of five weeks' duration. He had been having similar attacks of hoarseness for the past five winters.

Examination revealed a flat, slightly irregular mass involving the mesial part of the left arytenoid and the left half of the interarytenoid space. The mass crossed and ascended anteriorly into the posterior part of the right vocal cord. A biopsy revealed a tuberculous condition. A thoracic examination showed that the patient had bilateral pulmonary tuberculosis.

(A recording of the patient's voice and speech was played.)

An analysis of this voice reveals definite characteristics common to such patients. The voice is rough and has a *breathy huskiness*. Resonance and inflection remain practically normal, and volume is not affected to the degree that the rough whisper would lead one to believe. The whisper seems to be a self-protective measure which such patients unconsciously adopt in order to avoid straining their vocal mechanism. Usually they can speak loudly when it is necessary, so that the apparent weakness in most cases is disproportionate to the size of the presenting lesion.

#### HYSTERICAL APHONIA

For purposes of contrast, I shall now consider a case in which the vocal condition was psychogenic. Although the loss of voice originally was due to an infection, it persisted long after the local condition had completely cleared up.

CASE 7.—J. A., a woman aged 20, a student nurse, was ill for five weeks with an infection caused by a hemolytic streptococcus. She was unable to speak above a whisper. After the infection had cleared up, she continued to speak in this whispered voice, in spite of all further local therapy, for ten weeks.

When she was referred to the clinic of the National Hospital for Speech Disorders examination disclosed nothing more than a slight bowing of the vocal cords, which could in nowise account for her almost complete aphonia. It was therefore concluded that her hypophonia must rest on a functional or psychogenic basis.

(A recording of the patient's voice and speech before treatment was played.)



The patient's speech was a scarcely audible whisper. However, in such patients, the whispered voice, whether of the low or the "stage whisper" type, has no wheezy quality, nor does it sound strained, as in the inflammatory conditions. The patients seem to appreciate unconsciously that their vocal condition is an escape mechanism, and therefore they usually accept it rather complacently.

In this case the patient was readily led to understand the true meaning of her symptom, and a brief psychotherapeutic interview brought about immediate and permanent results. After one hour's treatment her voice was restored.

(A second recording of the patient's voice and speech, made after one hour's treatment, showed a marked contrast with the almost complete aphonia of the first recording.)

Her voice, although decidedly audible, was still somewhat hoarse and lacking in volume. Because of long disuse of the larynx and of anxiety regarding her vocal powers, she still lacked confidence. Three days later the patient revisited the clinic, and another recording was made.

(A third recording of the patient's voice and speech was played.)

Her voice is now normal in all respects. Through continued use of the voice, volume has been restored, and because she has gained confidence and lost her anxiety regarding her vocal abilities, the attack is no longer weak and hesitant. The patient has continued to speak normally ever since.

In conclusion, I wish to reiterate that the laryngologist should be able to differentiate between the various types of hoarseness. He should readily recognize in the voice of his patient the wheezy undertone that accompanies malignant conditions of the larynx, the breathy huskiness of tuberculosis or the characteristic vocal changes that accompany other conditions which continually come under the laryngologist's observation. In other words, if he possesses a trained ear he should, in many cases, be well on the road to a diagnosis as soon as he hears his patient speak.

61 to 63 Irving Place.

# DEFECTS IN SPEECH IN RELATION TO DEFECTS IN HEARING

IRVING WILSON VOORHEES, M.D.

NEW YORK

The influence of defects in hearing and in speech on the social and economic success of civilized man is so obvious that it seems not to require any extended comment. And yet this very fact may give the reason that no thoroughly scientific study of the interrelationship of speech and hearing has been undertaken until recently.

A deaf child is put into a special school, where he is taught to convey his thoughts manually. In earlier days, it was taken for granted that one could not educate him in the broader sense, and so his training was largely vocational, and the one vocation for which every such child seemed foreordained was printing. Every deaf-mute had to become a printer, whether he wanted to or not.

Moreover, the "deaf and dumb" were naturally supposed to be "stupid," and so they were kept in a state of more or less blissful ignorance all their lives, having few continued contacts with perfectly normal men and women. No wonder they were thought to be "queer" and "abnormal" and entirely outside the bounds of the consideration and courtesy commonly accorded to "normal" men and women. The die was cast; their lot was predetermined, and, while kind and sympathetic neighbors not infrequently declared that it was "too bad" and "very unfortunate" and a "heart sorrow" to parents and relatives, it was the will of Divine Providence, and nobody could do much about it save to "put the child into an Institution."

No wonder, again, that when it became known what Anne Macy had done for the blind and deaf Helen Keller the world gasped with astonishment. Essays, articles and books came tumbling from the press, most of them stressing the "genius" of the unfortunate little girl who was so "bright" that she had actually learned to talk and hear through the sense of touch. Prof. Alexander Graham Bell was interested in the Keller child as a "phenomenon," but it is doubtful if he ever dreamed that she could be educated even in the simplest sense, to say nothing of earning a degree from Radcliffe College! It required the far seeing, painstaking, scientifically minded, ingenious Miss Macy

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Read as part of a Symposium on Vocal Defects at the Forty-Fifth Annual Meeting of the American Laryngological, Rhinological and Otological Society, Inc., Chicago, May 11, 1939.

to work the miracle of "restoration," and miracle it was but in a strictly scientific sense only. All the elements were present with which this great teacher might work, but they were present also in other children. Miss Macy could have wrought her miracle in some other child had this other child been lucky enough to fall under her care. It happened that Helen Keller had the "I. Q." necessary for adequate tutelage, but she was no genius in her own right. She became a genius solely and truly because of her teacher. This she has always gratefully acknowledged on every possible occasion.

Speech defects are even more common than defects in hearing. They are present in every one and become manifest under undue excitement or nervous strain. The old experiment of asking some one to repeat a difficult sentence rapidly without error always brings forth a laugh. It takes no end of repetition to state correctly that "Peter Piper picked a peck of pickled peppers" or to utter the famous line about "Sister Susie's sewing shirts for soldiers" of the turbulent World War days. Every one soon had Susie showing shirts for shoulders. It was unavoidable. The mind is capable of working with lightning-like rapidity, but the motor pathways which coordinate the muscular movements of the tongue are blessed with no such agility. Moreover, one stutters not only with one's tongue but with one's hands and feet. An awkward person is one who "gets in his own way," who stumbles, knocks over furniture or upsets his glass of water regularly at table. Who has not stuttered on the typewriter? One sets down what one thinks is a pretty sentence, but when one comes to revise it letters are turned around out of their natural order in a word, words are omitted entirely or a terminal letter or syllable is missing. It is compromising to one's sense of intellectual superiority. Yes, one stutters not only with one's tongue but with one's body. For some, perfect coordination can never be acquired. One can, of course, improve one's status, but one can never perfect it.

Although defects of speech and hearing are closely allied at times, they are often separate and independent. Errors in speech are, indeed, so common that they outnumber defects in hearing two to one or perhaps in an even greater ratio. There is the example of the *lapsus linguae* of a learned college professor of literature who wished to excoriate the "blood and thunder" type of novel but who inadvertently called it the "thud and blunder" school. The story goes that he was, indeed, proud of his *bon mot* and more than willing to let it stand unchanged. This is, to be sure, not a *bona fide* example of a speech defect *per se*, but it illustrates the tongue twister to a nicety.

But the profoundly deafened person always has trouble with voice production, because he does not know whether he is speaking too loudly or too softly, distinctly or indistinctly. He probably has more trouble

with pitch than with quality. In aural testing there is a "reading test" which was developed by Bárány while I was in Vienna many years ago. For this, one needs a noise apparatus or two of them if testing the voice of a normally hearing subject for conversational effect. The subject is asked to read and to continue reading without a stop. As soon as one has heard enough of the ordinary voice, the noise-producing instruments are set to work in both ears, with the result that the subject will raise his voice to a shout in an effort to hear what he is saying. It is obvious that if one has total deafness in one ear and the instrument is set going in the good ear the same result will take place, and the patient will raise his voice. This is essentially a test for unilateral destruction of an aural labyrinth.

A rough classification of the subject allows five headings under which one may set down such cases as fall under the observation of otorhinolaryngologists.

1. Anatomic defects are most often congenital, but some occur as the result of the effort to grow up and live in a world full of pitfalls for the struggler who would survive the "slings and arrows of outrageous fortune." Dr. Greene has dealt so fully with the speech incident to such conditions as cleft palate, hare lip and dental malocclusions that it need be mentioned by me only *en passant*. Diagnosis can often be made by the ear alone. Treatment is, of course, surgical, followed by training in the art of speech. No matter how well the surgical work has been done, or how excellent the healed area looks, training in speech is necessary in every case. Barring this, specialists have not completed their task. Not only do parents have to be advised, but they often have to be commanded, to put the child under a teacher of speech, the selection of whom must be made by the physician and not left to just anybody who happens to be around, for bad or inefficient teaching puts a black mark against every one concerned and may vitiate a child's entire future.

2. The severe colds of childhood, often misnamed "purulent rhinitis," take their toll of hearing, especially when superinduced by diseased tonsils and adenoids, the result of many attacks of "sore throat." In the presence of enlarged, infected adenoids, extension into the eustachian tubes is the rule, with frequent earache, otitis media, mastoid infection or complications resulting therefrom—a march of events that is the same old story to the specialist but a sad, sad story for the growing boy or girl. To be sure, many recover completely, with excellent hearing, but before one discharges such a patient from one's care one ought to be sure that treatment of the nose, throat and ears (including inflation) has done all that is humanly possible to restore the hearing. One ought to be particularly certain that there are no "rests" or foci of lymphoid tissue, which are so often the habitants of

the fossae of Rosenmüller. Such areas are easily destroyed by the engaging finger, and an operation for adenoids is not complete unless one carries out this simple procedure.

Sinusitis in children has been so fully written up by pioneers like Dr. Lee Wallace Dean and the late Dr. Lewis Coffin that one need do little more than mention it. However, there is still plenty of evidence to show that the condition is often overlooked or, if diagnosed, is poorly managed, partly because children under 12 years are so hard to work with, defeating, as they so often do through fear, every effort to help them. Parents, too, often dread the "ordeal" and fail to keep returning for office treatments.

Diplomacy and tact will be tried to the utmost by such patients, and one may have to resort to all kinds of bribery and cajolery to keep them coming. Parents are often difficult, even recalcitrant, and seem to assume that the doctor is merely "trying to run up a bill." This is a good argument for a flat rate arrangement whereby the patient must continue his visits, regardless of the number, until one releases him from that obligation. In the following case the parents had to be educated to their obligation.

A boy 9 years of age was brought in by both parents for examination of his hearing. At 4 years he had undergone tonsillectomy and adenoidectomy, which seemed successful, but for a long time he had recurrent colds; the latest, which was still with him, followed an orgy of wading through pools of water after a hard rain! The story was that he went for months without "ear trouble"; then his ears pained and discharged freely. It was regarded as "just one of those things," and it seems not to have occurred to the parents that an otologist ought to be consulted, until twenty-four hours before, when the left ear discharged *blood!* This caused alarm; it is always fortunate for the patient when a show of blood brings him to a physician, but too often this comes late rather than early in the course of a disease. Here it came early or, at least, early enough. Examination showed purulent discharge from both ears. There was bright red blood on the cotton used to wipe out the left one. Underlying it was a large perforation, plugged by granulation tissue. Hearing in both ears was reduced to about 50 per cent of normal, but one could not be sure what it ought to be when the ears were quiescent. The tonsils had been well removed, but there were definite rests of adenoid tissue around both tubes. When told that the nasopharynx required surgical treatment, the parents demurred. What was the use of going through all that again when it did no good the first time? It required much persuasion and argument to secure permission to send the boy to the hospital. However, this was done; the infected masses were cleaned out, and within a few days the pharynx was healed; the ears were dry, and the hearing was within 10 per cent of normal. If the tendency to colds continues, an effort will be made to secure an autogenous vaccine. Sinal studies (stereograms) will be carried out, and whatever treatment is then indicated will be advised and, it is hoped, carried to a successful completion.

In many cases such early deafness is curable if the otologist can only secure the full cooperation of parents or guardians. This is the

most favorable of all types of obstructive deafness of infectious origin in its response to the efforts of the otologist.

Vocal defects in this classification are commonly associated with colds in the head. There is a lack of nasal resonance. The child is said to talk *through his nose*, which is, of course, a misinterpretation of fact, for he talks *without his nose*. The turbinals are swollen so that they act as a cushion to sound and prevent air from vibrating within the nasal fossae. What one hears is described as "muffled" or "denasalized." Awkward shifts in vocal placement or register take place, but these are only temporary, and they clear up with the subsidence of the conditions which brought them about.

3. Speech defects associated with loss of hearing for certain frequencies are common. The patients usually refer to themselves as "slightly hard of hearing." They do not admit that they are deaf, for the natural tendency is to minimize this fault lest they should be thought stupid. Such losses may be found in the low pitch range, and in this event the voice is strident, hard or muffled and largely uninflected, giving rise to a disagreeable monotone which is often accounted for by saying that a person is "pitch deaf." When such a condition begins in childhood, enunciation of syllables and words is imperfect, and a condition arises which psychologists call "retardation in general language skills." When such partial losses of hearing take place in the high pitch range, even in the zone which lies beyond that generally used in association with speech, difficulties of articulation are constant. Most of them are concerned with consonants, particularly sibilants. From childhood, speech defects persist in the form of "baby talk" or lisping or of general retardation in the development and use of the subtler phases of expression.

Any loss of hearing and speech in this classification calls for something more than merely medical care. There must be, in addition, a pedagogic approach to the problem, and, in my opinion, only teachers of speech who are qualified by training and experience should undertake the education of both hearing and speech. It is useless and wrong to stress either skill at the expense of the other.

4. Profound deafness in children is either congenital or acquired, and in by far the greater number it is acquired. There are, indeed, few congenital deaf-mutes, for careful study will show islands of residual hearing previously unknown to have existed. In 1910 Prof. Alfred Denker, of Erlangen, published a monograph on "Die Anatomie der Taubstummheit" to which contributions were made by Quix and Brouwer, Uffenorde and Schönemann with an integration of their findings by Denker himself. They carefully analyzed in all details the microscopic anatomy of the labyrinth and brain in a deaf mute, but

regarded the case as a "find," a *rara avis* in the field of pathology. Many who are thought to have been born deaf suffered a severe infection, syphilis or meningitis, in the prespeech period, and the condition was, therefore, set down as congenital.

For otologists the question has, however, only academic interest, since the loss of all serviceable hearing classifies a person as deaf-mute, no matter what the pathologic studies might show. It is much more important to recognize that such conditions have been regarded as hopeless throughout all time and that no one has tried to do much about them until recently. Dr. Max Goldstein, of St. Louis, was a pioneer in undertaking this important task, and to him belongs much of the credit for the present efforts to ameliorate the fate of the profoundly deafened.

The acute infectious diseases of childhood, especially scarlet fever and meningitis, have taken a heavy toll of the labyrinth and of the auditory pathways in the brain as well. Acute suppurative labyrinthitis and meningitis used to be common in childhood. They are less so now because of an increased knowledge of their origin and management and also because means of human communication have so greatly improved that no one lives far from a center where prompt medical care can be obtained. Children are still committed to schools for the deaf but are being cared for by otologists, so that such factors as disease of the tonsils and adenoids, chronic discharge from the ears and other basic elements are removed, giving a chance to the teacher to develop whatever residual hearing may be present. For many years the sign language has been pushed further and further into the discard. In its place have come lip reading and the use of electrical amplification properly based on the results of audiometric studies. Hearing aids are still imperfect, but they have improved marvelously during the past five years because engineers, physicists, psychologists and otologists have combined their efforts to solve the problem of making the deafened hear. That problem also involves the teaching of speech, urging the pupil to try to imitate the sounds he hears. Fortunately, speech centers and speech organs are usually intact after the smoke of battle has cleared and the fight for life has been won by the little patient. The effort to hear followed up by the effort to speak is, unfortunately, fatiguing. It makes great demands on the nervous system, and only a little can be accomplished at one sitting. Moreover, once the pupil is released from a classroom he throws aside his hearing aid and reverts to signing, since that is along the line of least effort to establish communication with others.

Then too, the pupil shrinks from normal persons as much as he can, preferring the society of fellow sufferers. This delays satisfactory adjustment, vitiates results and makes the teacher's task much harder than it ought to be. All that it is intended to point out in this little

essay is the necessity for the otologist to cooperate with teachers, manufacturers of hearing aids, physicists and electrical and radio engineers in order that he may do his part in trying to restore the deafened person to a better place in society, thus helping him to earn a living and to remove a heavy burden from taxpayers, philanthropists and the state. It can be done, and it is being done in many cities and centers within the United States. England, however, has gone ahead much faster in her work with the deafened and has made excellent contributions through studies in the public schools and in laboratories of all kinds.

If deafness has occurred after speech has been well developed, vocal defects are not so marked, but there is often nasality, poor inflection and awkward shifts between guttural and high-pitched, strident tones and always that dread monotone so characteristic of deaf-mutism.

5. Profound deafness in adults brings about changed quality of speech and intensity. Nerve deafness is always associated with a peculiar voice. Since the patient cannot hear his own voice he either shouts or mumbles, and in either case it is difficult to understand him until one has become accustomed to his method of production. The effort is made to hear one's own voice, with a result that is harsh and unpleasing to the listener, who soon tires of trying to carry on a conversation. Too often the deafened person insists on doing all the talking so that he will not be bothered with questions which he can neither hear nor understand. With conduction deafness, as distinguished from nerve deafness, voices are generally faint, mumbling and indistinct.

The varieties of speech are as numerous as the sands of the sea. Every one possesses the inherent ability to vary the voice in pitch, quality and intensity. One can so change one's voice as to make it absolutely unrecognizable when one is out of sight, even by the friends who know one best. The voice one happens to claim as one's own is the result of a settling down after puberty and it is high, medium or low according to individual characteristics. The spoken voice is, however, a poor index of virility or effeminacy. One of the most masculine men I ever knew had a miserable, high-pitched, disagreeable voice, which carried no conviction, chiefly because no one ever listened for the thought conveyed by it. The listener was aware only of the mechanical effect on his auditory mechanism and not at all, or rarely, of the message the speaker was attempting to convey. And the pity is that that man need not have gone through life with such a voice. It could have been brought down by a skilled teacher to almost any desired level and kept there through paying attention to the quality and the method of production. It might never have been beautiful, but it could have been made effective.



It is not true that a normally hearing and speaking person has no idea whatsoever of the kind of voice he has. Every one knows whether he speaks in a high or low voice; he ordinarily knows when he shouts (save in anger, when one is almost entirely objective) and when he speaks in a subdued manner. But in truth persons seldom pay much or any attention to their method of speech. They indulge in a badly produced, badly modulated voice, which grates and rasps on listeners and defeat their social aims without realizing the fact. Elegant speech is such a rarity that one is almost shocked when one hears it and is led to exclaim, "What a beautiful voice he has!" But all hearing persons, if they were as interested as they really ought to be, might well have a pleasing speaking voice if only they were willing to "listen in" on themselves and correct obvious faults in production.

Reading aloud, which is a lost art to most, is one of the best ways to observe one's own way of speaking. In fact, the reader may not understand a word of the thought being conveyed if he is intent on the manner of its conveyance. A year or two ago, I thought it would be a rather nice gesture to make a record of Kipling's "If" and Henry van Dyke's "America for Me" and pass it on to my growing son as a Christmas present. When the thing was done and the opening of gifts was in order, I proudly brought forth the disks, put them on the playing machine and watched for the result. At the end of the first piece, the boy turned and said: "Who on earth was that?" Well, the result was not flattering! I suppose that in my great desire to produce a good and faithful record I overstepped and made my voice sound quite different from its usual style.

Some preachers, whose noble work in life it is to expound the scriptures and induce an audience to think, for a time at least, on higher things, have little or no accurate idea of delivery. They stand on tiptoe and scream or bawl at their hearers in a way that is little short of ludicrous, much as one should like to be kind and tolerant of them. They have not been taught, or, at least, they have not learned, how to speak effectively. This is true of many sects and divisions of the Christian church. In all fairness, however, one may largely absolve the clergy of the Church of England, many Catholic priests and the rabbis who speak from the radio. Most of them have fine, well modulated, resonant voices and carry a feeling of reverence and conviction to their hearers. The Lord's Prayer and the Sermon on the Mount may well be ruined for a listener by the speech pattern of the ecclesiast, who seems well convinced that he is uttering great teachings in a thoroughly legitimate manner. Most voices, let it be said, which are heard via the radio are well produced and effective. Somehow the radio has a way of weeding out bad voices save when the speaker is strictly on

commercial programs. The sustaining programs usually have fine, polished and thoroughly "listenable" voices.

As for university lecturers, it is a bit startling to find that many of them have had no training in speech or hearing whatsoever. They are employed on evidences of their intellectuality, usually based on written theses or published books, plus sufficient academic "pull." Many of them know little and care less about their manner of delivery. It is sufficient to cast their pearls of wisdom in any manner that pleases them. If the student can pick them up, very well, but if not it is his fault and not the fault of the speaker. But all that is going to be changed, and better speech is likely some day to come into its own even in the seats of higher learning.

At Syracuse University the general health examination of entering students now includes audiometric measurements and speech tests. The student health service and the school of speech have combined in an attempt to disclose each student's actual difficulties in hearing and speech. Surprising results are being recorded. For example, one student insisted that he was not very deaf. An audiogram showed more than 80 per cent loss of hearing in each ear! Another, who complained that he had a great deal of difficulty in hearing lecturers and who had been undergoing corrective treatment for dyslalia for some three years, was found to have a loss of hearing of only 12 per cent in one ear and 15 per cent in the other!

Let it be hoped that other universities will imitate the good example set by Syracuse.

Voices convey to a listener something by which he judges mentality and strength or weakness of personality. One may be misjudged in a downward direction; seldom is one rated upward if quite unworthy of good opinion. Few succeed in life in mastering men if they have voices that grate on the nerves or are otherwise deficient to the listening ear. A notable exception to this rule was the first President Roosevelt. He was possessed of a shrill, high-sounding, penetrating voice, but somehow the message he conveyed was all absorbing, so that no one paid much attention to the way in which it was delivered. But then "T. R." was a law unto himself in every other way as well. He set a pace in all things which few men in the world, past or present, have been able to emulate successfully.

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# A SIMPLE TREATMENT FOR DEFECTS OF THE SINGING AND OF THE SPEAKING VOICE

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It is not proposed in the discussion of this subject to describe the various methods of treating defects of the singing and of the speaking voice employed by the laryngologist, who is devoting much time and thought to this branch of his specialty. It is my present purpose to discuss a simple method of treatment to be applied not only to defects of the singing, but also to defects of the speaking, voice, encountered in daily practice. Public speakers, teachers, actors and preachers often consult the laryngologist for a defect of the speaking voice, but there is also a vast number of patients who misuse the voice and whose defect remains unrecognized and improperly treated. I refer to saleswomen, persons reading to the blind, persons attending cocktail parties or teas, who use their voices in the presence of a loud and constant noise, and those who speak loudly to the deaf. These patients may complain of vague pains in the neck and of hoarseness caused by mild paresis of the internal tensor muscles—in other words, acute vocal fatigue—and are often treated for laryngitis instead of for phonasthenia.

It has struck me forcibly that a singer who has been treated by electric phonic compensation for acute phonasthenia in order that he or she may be able to fill an allotted engagement is unable, in the majority of instances, to receive the same treatment by a laryngologist in another city, when on concert tour. There is certainly no good reason for such a circumstance, as the treatment is simple and in acute conditions effective and should be known by every laryngologist. To bring this subject to the attention of members of the medical profession is the sole purpose of this paper.

If a singer is physically and mentally fit and if he sings in a manner physiologically correct, there need be no concern about the condition of the larynx, provided he does not sing to excess. It is perfectly apparent, however, that, should there be some systemic derangement, the delicate mechanism of the vocal cords becomes easily disturbed. The principal systemic causes of vocal fatigue are anemia, pulmonary tuberculosis, heart lesions, chronic toxemia, pregnancy, menstruation and

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endocrine dysfunction. The last named, in the form of hypothyroidism, is a frequent cause and must be given the attention it deserves.

Local causes, such as chronic laryngitis, singer's nodules, dilated blood vessels of the vocal cords, enlarged lingual tonsils, infected faucial tonsils and adenoids, abnormalities of the nose causing obstruction and disease of the paranasal sinuses, may be contributing factors.

The chief cause is usually misuse of the voice. This, according to Flatau,<sup>1</sup> may be quantitative or qualitative. The first applies to the use of the voice for too long a time and the second to a faulty method. Qualitative factors may be summarized as follows: forced fixation of the larynx, *coup de glotte*—i. e., rapid approach of the vocal cords in reaching a note—*improper use of the lips, tongue and lower jaw, insufficient and forced vocalization, improper breathing, lack of relaxation and the use of the voice in the presence of an acute infection of the upper part of the respiratory tract.*

One of the first symptoms complained of by the patient is a feeling of fatigue in and about the larynx. A tired feeling after great exertion is not unusual and is not to be looked on as one of the symptoms of phonasthenia. The tired feeling which is of concern to the laryngologist is the one which occurs earlier, as a rule about fifteen minutes after one begins to sing or speak. When pain becomes a prominent symptom, it may localize itself in the larynx or in the occipital region and may radiate to the shoulders and sternum in some cases.

Parasthesia is often present and is usually disturbing to the patient. The parasthesia is not well localized. It may be in the postnasal space, nose or larynx and may occur in the form of pressure, dryness, burning, itching or a sensation as though a foreign body were present, or "globus hystericus."

The objective symptoms are those one hears and sees. When intensity is disturbed, the patient cannot sing or speak in a loud tone, and the voice is changed in character. A disturbance of extensity means that the singer has lost some of the notes or has a tremolo. The most frequent symptom is detonation—in other words, the patient sings flat—and he is many times not aware of this defect.

The laryngeal examination may reveal changes in the form and disturbances in the movements of the vocal cords. The following changes may be seen: singer's nodules, glandular cysts, irregularity of the free edge of the cords, thickening of the interarytenoid space and changes in color. Singers do not have a normal color of the cords. There is usually a roselike tint, more pronounced after singing, which is in reality an occupational hyperemia—in a way a physiologic change.

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1. Flatau, T. S., in Denker, A., and Kahler, O.: *Handbuch der Hals-Nasen-Ohrenheilkunde*, Berlin, Julius Springer, 1929, vol. 5, p. 1301.

The disturbance of movements of the vocal cords may be twofold; first, there may be a lack of movement, with incomplete closure, and, if the paresis is mild, there may be some difficulty in recognizing its presence. Second, fortunately rarely, the adductor muscles may be so strong that the arytenoids override and asymmetry results.

It must always be remembered that the larynx is sensitive and that, as the adductor and abductor muscles do most of the work, misuse of the mechanism will result disastrously. Circulatory and secretory disturbances may occur in the larynx, and a catarrhal inflammation of the vocal cords, with hypersecretion of mucus, is the result. The catarrhal inflammation is usually confined to the larynx itself, the upper respiratory regions being unaffected. On examining the larynx one often sees a sticky plug of mucus, hard to dislodge, lying on the vocal cord. If phonasthenia has been present for a considerable time, dilatation of the blood vessels of the vocal cords with thickening of the free edges may follow. If there is marked thickening of the cords, paresis of the internal tensor muscles may easily be overlooked.

It is well known that each singing teacher has a distinct method of his own, when in reality there is only one method of teaching the art of singing and that is the one by which it is done in a physiologically correct manner. Furthermore, it happens in many instances that all students are instructed in a like manner, which is undoubtedly a mistake, since individual attention should be given to the faults of each singer and an attempt should be made to correct these faults along physiologic lines. One of the details most frequently overlooked—and one which is difficult to master—is diaphragmatic breathing with proper control of the abdominal muscles. Vocal fatigue will continue to be frequent so long as singing teachers continue to use their special method on every pupil, fail to individualize instruction for each voice, allow the pupil to sing loud in order to overcome the beginning paresis of the vocal cords, permit him to sing in the presence of an acute cold and suggest that he should practice hours at a time in order to develop and strengthen the voice. A voice properly trained may continue to functionate in a splendid manner until, as the result of excessive singing or the development of a faulty technic, the first symptoms of phonasthenia, such as detonation and a slight tremolo, make their appearance. I am rather inclined to the opinion that many voices could be saved if a functional examination of the larynx by means of phonic compensation were made at stated intervals. If this were done, vocal fatigue would be detected in its early stage and, with a few treatments, easily corrected.

I shall endeavor, in a brief way, to discuss the salient points pertaining to the examination of the phonasthenic patient. Indirect laryngoscopic examination has its disadvantages, as the parts are dis-

turbed when the tongue is protruded. However, fine changes on the vocal cords may be more easily recognized by using a magnifying laryngeal mirror. The character of the breathing should, if possible, be ascertained. To determine the length of expiration, the patient is asked to take a deep breath and at the time of exhalation to hum the consonant "m." Many times it will be noticed that a large part of the expiratory current of air is rapidly expended. This is a faulty method of breathing and shows lack of control of the abdominal muscles and improper diaphragmatic action. It is needless to add that if this type of breathing is continued for any length of time vocal fatigue will follow. By placing a band in the region of the diaphragm and asking the patient to expand the band by taking a deep breath and allow for a slow retraction of the abdominal muscles while humming the consonant "m," proper breathing is easily taught. This humming exercise is of great benefit also to public speakers who are inclined to use a high-pitched voice, thereby elevating the larynx, instead of keeping it in a normal position while speaking.

There are two tests which may be used when a singer's chief complaint is lack of resonance; namely, the "ah ee" test of Gutzman<sup>2</sup> and the cocaine test. In the "ah ee" test the singer enunciates "ah ee" and at the same time opens and closes the anterior nares repeatedly by compressing them with the fingers. In rhinolalia aperta an increase in the nasality occurs, and in rhinolalia clausa there is no difference in the tone of the voice. A nasal obstruction may, therefore, be the cause of the lack of resonance if no difference in the tone is heard. In using the cocaine test, a small quantity of a 2 per cent solution of cocaine is sprayed into the nose, and the resonance of the voice is tested by having the patient vocalize before and after its use. If the resonance is improved, a nasal operation may be indicated. It should be emphasized, however, that the removal of a large amount of tissue from a singer's nose may produce a marked change in the voice of a character not pleasing to the ear. In many instances, conservative measures for the reduction of edema of the inferior turbinate, such as application of trichloroacetic acid or electrocoagulation will suffice.

The question often arises, When should tonsillectomy be performed on a singer? The decision is easily reached if it can be shown that chronic infection of the tonsils is undermining the general health of the singer and that the infection is interfering with proper movements of the soft palate. When it has been decided that a singer needs tonsillectomy, it is well to establish before the operation is undertaken whether there is a defect of the singing voice. The tonsillectomy can, therefore, not be blamed for a detonation discovered before the operation if it persists after healing is complete. The operation itself should be done

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2. Zumsteeg: Ueber Phonasthenie, Arch. f. Laryng. u. Rhin. **24**:1, 1910.

with the greatest care, so that injury to the soft palate is reduced to a minimum. The postoperative period should be rendered as free from pain as is possible by making free use of powders containing acetophenetidin, acetylsalicylic acid and codeine. Intense pain after the operation is followed by severe reaction, and the latter, in turn, is productive of scarring and retraction of the soft palate, which is undesirable in a singer. The patient should not take a prolonged rest after the operation but should, instead, begin mild vocal exercises at the end of two weeks, vocalizing more each day, so that in a month the full voice may again be used. It is known that some patients complain of dryness of the throat following tonsillectomy. When this occurs in the singer, it may, as shown by Stern,<sup>3</sup> be the result of chronic stage fright, for it is known that the mouth and pharynx are dry when one is undergoing a severe nervous strain.

It is easy to understand why detonation is a frequent defect of the singing voice when one remembers the delicate structure of the laryngeal muscles and the abuse which is imparted to them when their mechanism is disturbed by improper singing and speaking. It is unfortunate that many times a singer does not know that a flat note is being sung and does not realize that there is anything wrong until a distinct break takes place. In such cases one is usually dealing with advanced phonasthenia. Generally speaking, however, there is a loss of clearness of tone, and the experienced singer recognizes it on attempting to vocalize. How is the laryngologist to know when false notes are being sung? This is done by the use of the chromatic pitch pipe. Beginning with a low note, the pitch pipe is blown, and the patient is asked to sing softly (*pianissimo*) the vowel "o," preferably "lo," each time a note is emitted from the pipe. If possible, the entire chromatic scale is tested, and the laryngologist makes note of the following:

1. Clearness of tone.
2. False notes.
3. Break in the voice.
4. Ability of the patient to hold a given note.

It is perfectly apparent that the foregoing method of examining the singer can readily be used by the laryngologist who has a musical ear. The question arises, how is one to proceed if the opposite is true? In this instance, the statement of the patient regarding the presence of a vocal defect is sufficient reason for proceeding with the treatment of the voice.

It is my intention in discussing treatment of phonasthenia to speak only of a simple method, the use of which has been found satisfactory

3. Stern: Die Tonsillectomie in der Sängerpraxis, *Ztschr. f. Hals-, Nasen- u. Ohrenh.* 15:193, 1926.

in the majority of instances. I refer to the application of a mild faradic current to the exterior of the larynx during singing and speaking. It is a known physiologic fact that when a note is sung and a mild faradic current is applied to the exterior of the larynx, the pitch will rise. It therefore follows that if a singer is singing flat the faradic current will compensate the detonation and will cause the pitch to rise and the note to be sung in a normal, clear tone. This is termed electric phonic compensation. The strength of the faradic current should be such that the patient barely feels it. There must be no pain or muscular contraction. If this occurs, the opposite takes place—the note breaks and phonic collapse may result.

Imhofer<sup>4</sup> rightly emphasized the fact that by the use of electric phonic compensation one can determine whether a patient is able to fill a singing engagement. If, while one is using electric phonic compensation, each note rises in pitch and notes which were sung flat once more become normal and clear in tone, the laryngologist need not hesitate to advise that the singer keep his or her engagement. In fact, the outcome of the functional faradic compensation tests is far more important than the appearance of the larynx when a decision is to be reached as to the advisability of allowing a singer to perform. It is obvious that the exception to this rule is the presence of acute laryngitis.

In applying the treatment, the laryngeal electrode, moistened with saline solution, is placed on the neck about a centimeter from the thyroid cartilage. Beginning with a low note of the scale, the tone is given by the pitch pipe, and the singer sings the note in pianissimo by using the word "lo." The faradic current is not applied until the patient has begun to sing and is continued so long as the note is being held. Four or five applications of the faradic current are usually made to each note before proceeding with the next note higher in the scale. It is self evident that if a tone rises on application of the electric current further stimulation on that note is unnecessary. Detonation usually occurs—especially in sopranos—at D and E of the middle register, and in cases of acute vocal fatigue is readily compensated. By having the patient vocalize before and after the treatment, the effectiveness of phonic compensation may easily be determined. When treatment for vocal fatigue is used on patients who are not singers, the faradic current is applied while the patient is speaking, care being taken that proper breathing and tonal placement are being used.

It is often suggested to singers who have a defect of the voice that they take a prolonged rest. This is good advice if singer's nodules are the cause of the trouble, as nodules have been known to disappear

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4. Imhofer, R.: *Die Ermüdung der Stimme (Phonasthenie)*, Würzburg, Curt Kabitzsch, 1913, p. 83.



after three or four months' rest of the voice. With phonasthenia, however, it is advisable to have the patient continue singing in a milder degree, if possible, and to institute treatment by means of phonic compensation. The presence of a plug of mucus may necessitate irrigation of the larynx with a physiologic solution of sodium chloride or, better still, with the following solution:

Alcohol .....	30.0
Oil of peppermint.....	3.0
Distilled water .....	150.0
Filter.	

It is worth mentioning, however, that local treatment alone, without phonic compensation, is usually of no avail against catarrhal affections of the larynx resulting from misuse of the voice.

It is not within the scope of this paper to describe other methods of phonic compensation. It was my desire to explain a simple method, one which requires no special training in the treatment of vocal defects and one which can readily be used. When once understood, this method of treatment of defects of the voice in singers, public speakers and other patients becomes simple and practical, and because of its simplicity it should be a routine measure of every laryngologist.

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# THE VOICE AFTER DIRECT LARYNGOSCOPIC OPERATIONS, LARYNGOFISSURE AND LARYNGECTOMY

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PHILADELPHIA

Voice is the chief consideration in the treatment of most benign laryngeal conditions. In malignant conditions voice must obviously be relegated to second place, because the first and most urgent indication is to cure the cancer. It is necessary to explain this to the patient and his family, so that they may readjust their attitude and accept whatever vocal impairment may be entailed in the procedure required to obtain the proper prospect of cure. However, the fact remains that one of the things that the patient is most anxious to know before consenting to the necessary operation is whether he will lose his voice. Many people believe that removal of the vocal cords will make it impossible for them to talk, and the majority of those to whom total laryngectomy is advised are skeptical when assured that they will soon learn a new way of talking after the larynx is removed. It is explained that voice is relatively unimportant as compared with the cure of the cancer, which is inevitably fatal if untreated, but it is comforting to the patient and conducive to his fit condition for operation, as well as a consolation to his family, to know that he will not be doomed to use sign language or a pad and pencil the rest of his life to express himself.

It seemed to me that it would be interesting and helpful to conduct a special follow-up on patients who have had the various laryngeal operations, by sending out questionnaires regarding postoperative vocal development. Of the first group of patients, those to whom direct laryngoscopic treatment was given, only one small series was questioned, patients for whom nodules of the vocal cords ("singers' nodes") had been removed. Of the second, those who had had more radical operations, for the extirpation of cancer, all living patients operated on since 1929 were sent questionnaires. Replies were received from 51 patients who had had one or both cords removed by laryngofissure and from 30 patients on whom total laryngectomy had been performed.

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From Temple University Hospital.

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## THE VOICE AFTER REMOVAL OF NODULES OF THE VOCAL CORDS

Direct laryngoscopic procedures<sup>1</sup> are done for the treatment of papilloma, organizing hematoma (benign tumor of inflammatory origin), polypoid corditis, eversion of the ventricles, nodules of the vocal cords and many other conditions, but only the group treated for nodules of the vocal cords was chosen for questioning. This group was chosen for two reasons: first, because it was relatively small and, second, because there has been some difference of opinion as to whether such nodules should be removed and as to the permanence of the result obtainable by removal.

After the removal of papillomas or other benign true tumors, unless the underlying normal tissues have been damaged by the present or some past procedure, by secondary inflammation or by excessive strain, the voice will be restored. One interesting observation that I made recently in a case of chronic papilloma in an adult might be mentioned here. Whenever the papilloma recurred slightly a tendency to phonate with the ventricular bands was noted; the bands appeared to attempt to reenforce the true cords, but the result was not satisfactory. Removal of even a small amount of papillomatous tissue from the margin of the true cords was sufficient to restore normal cordal function and a good tone of voice. The patient is a lawyer, and his voice is important to him. The phonation with the ventricular bands would probably be classified as "vicarious" in this case, though the mechanism came into play so readily that it might be considered "usurpative."<sup>2</sup>

The removal of "organizing hematomas" should be followed by perfect restoration of voice unless chronic laryngitis is associated or the normal tissues are damaged by unskilled use of the forceps. My colleagues and I have always advised scalping off benign tumors superficially without making any attempt to deal radically with the base. We prefer to leave the cordal margin slightly convex rather than concave. Not infrequently it is best to remove the tumor in two or three stages, but in the majority of cases it can all be removed at one.

In polypoid corditis and eversion of the ventricles, an amazing improvement in voice can be obtained by carefully scalping off the excess tissue, first from one side and later from the other side of the larynx, but it is always worthwhile to prescribe for patients with these con-

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1. Jackson, C., and Jackson, C. L.: *The Larynx and Its Diseases*, Philadelphia, W. B. Saunders Company, 1937; *Cancer of the Larynx*, J. A. M. A. **111**:1986 (Nov. 26) 1938. Jackson, C. L.: *The Indications for Direct Laryngoscopy*, Tr. Am. Laryng., Rhin. & Otol. Soc., 1939, to be published; *Ann. Otol., Rhin. & Laryng.*, 1939, to be published.

2. Jackson, C., and Jackson, C. L.: *Dysphonia Plicae Ventricularis: Phonation with the Ventricular Bands*, Arch. Otolaryng. **21**:157 (Feb.) 1935.

ditions a preoperative period of about the same, or somewhat longer, duration, during which they should observe the greatest moderation in talking, smoking and drinking.

As already stated, there is some difference of opinion as to whether or not true nodules of the vocal cords should be removed, but it has been my experience that they rarely disappear spontaneously, whereas their removal by direct laryngoscopic procedure gives excellent vocal results and they do not, as a rule, recur. However, Ridpath<sup>3</sup> was probably correct in saying that if the nodules are not too well established they may disappear, provided faulty voice placement is corrected. Voorhees<sup>4</sup> stated the indications for treatment accurately in his book on "Hygiene of the Voice." Others who have discussed the subject are Imhofer,<sup>5</sup> Sokolowsky<sup>6</sup> and Prévot.<sup>7</sup>

Questionnaires were sent to a series of patients who had had nodules of the vocal cords removed, and at the present time 13 have replied. All but 2 of these stated that their voices were "good"; the other 2 said "fair." These patients had been hoarse for periods varying from three months to twelve years prior to operation. For the 10 patients who had been hoarse for a year or more, the average duration of hoarseness was over four years.

Despite the good results obtained in this series, I am inclined not to advise immediate removal of the nodule in the case of an operatic singer. I believe that in such persons a trial of vocal rest for two months, followed by gradual resumption of singing, is indicated, care being taken when singing is resumed to improve the voice placement and the manner of singing, in cooperation with the singing teacher. If the nodule persists after this program has been carried out removal may be again considered.

#### THE VOICE AFTER LARYNGOFISSURE

Patients who have had one or both true cords removed by laryngofissure practically always develop a useful voice, but its quality, pitch and carrying power vary greatly. Cicatricial "adventitious" cords develop in most cases, and in the patients with good voices, generally either one good cord remains, and a good "adventitious" cord has devel-

3. Ridpath, R. F.: Voice Production, with Suggestions for Treating Hoarseness and Loss of Voice in Singers, *Atlantic M. J.* **26**:831 (Sept.) 1923.

4. Voorhees, I. W.: *Hygiene of the Voice*, New York, The Macmillan Company, 1923.

5. Imhofer, R.: Ueber Sängerknötchen, *Ztschr. f. Laryng., Rhin., Otol.* **12**: 79, 1923.

6. Sokolowsky: Sängerknötchen und Stimmstörung, *Ztschr. f. Hals-, Nasen- u. Ohrenh.* **12**:246, 1925.

7. Prévot, M.: Le nodule vocal chez le chanteur, *J. de méd. de Lyon* **7**:411, 1926.

TABLE 1.—*The Voice After Removal of Nodules on the Vocal Cords*

Patient	Sex	Age	Date of Direct Laryngoscopic Procedure	How Long Were You Hoarse Before Treatment?	Is Your Voice Good? Fair? Poor?	Do You Address Groups?	Did You Sing?	Are You Able to Sing Now?	Comment
1. M. A. A.	F	32	11/22/37	About 1 yr.	Good	No	No	No	"I wish to express again my sincere thanks to you, as I consider the operation very successful."
2. A. B.	F	35	1/19/39	7 mo.	Good	No	No	No	
3. H. C.	F	42	6/17/35	2 yr.	Good	No	No	No	"I have had no trouble whatever with my voice since your operation."
4. M. A. D.	F	44	11/28/38 12/12/38	About 12 yr.	Good	No	No	No	"My voice was improved 100 per cent, and I consider the operation a complete success."
5. C. G.	F	42	7/13/36 7/23/36	10 yr.	Good	Yes	Yes	No	"I find that my voice tires more easily than before I became hoarse. I had a strong vibrant voice before the hoarseness. Now my voice, although clear, is not as strong."
6. S. J.	F	17	3/ 9/39	3 mo.	Good	Yes	Only at school	A little	"When the weather is bad my throat is irritated."
7. C. J.	F	39	11/22/34	About 3 mo., continuously	Good	No	No	No	"As my record probably shows, I became hoarse when about 21 years old, while teaching school. I had recurring attacks several times yearly, even after giving up teaching. The condition was always worse in bad, misty or foggy weather or when I was under mental or physical strain. Since operation I have had no attacks of hoarseness, and my voice is not affected by the weather, colds or my general state of health. I am much pleased with the results of the operation. My voice has a husky, sometimes slightly strained, tone, but I do not get hoarse or lose my voice as I did for so many years."
8. B. K.	F	31	6/18/31	About 2 yr.	Good	No, but I teach	No	No	
9. A. S.	F	43	9/12/29	2 to 3 yr.	Good	No	No	No	"I have hoarseness only when I do excessive talking or use the telephone."
10. E. F. S.	M	59	10/12/36	About 1 yr.	Good	No	No	No	
11. J. J. T.	M	46	11/ 5/36	Approximately 14 mo.	Good	Occasionally	No	No	"If I talk too long at one time my throat seems to get dry and somewhat fatigued."
12. M. T.	F	39	11/15/34	1 yr.	Fair	No	No	No	"I am happy to state that the operation helped me and that I feel much better."
13. O. P. G.	F	35	9/27/37	For years	Good	No	No	No	"The only time I ever notice any hoarseness is when I am overfired and I have to talk over the noise of music or there is a large group of people and a lot of noise."

oped, with which it can approximate and vibrate, or two good "adventitious" cords have formed to replace two cords that have been removed. Another mechanism by which a good voice can be produced is phonation with the ventricular bands,<sup>2</sup> which is to be regarded as undesirable when it is "usurpative" but which may afford an excellent and efficient substitute for phonation with the true cords when one or both cords have been removed. One of the factors that is of importance in determining the character of the voice is the degree of motility, and this in turn generally depends in some measure on how much of the arytenoid was removed and how severe the inflammatory reaction was in the crico-arytenoid joint. The presence of a granuloma may interfere seriously with the production of a good tone, and such tissue should be removed by direct laryngoscopic procedure if it does not shrink and disappear in a month or two after operation. Sometimes several removals are necessary. In still other cases the voice is impaired by a cicatricial web across the anterior commissure.

Of 51 patients submitted to laryngofissure in the past ten years who have answered the questionnaire at the present time, 43 replied in the affirmative to the question "Have you developed a useful voice since your operation?" To the question "Is your voice good, fair or poor?" 8 replied "good," 37 "fair" and 6 "poor." Persons with a great variety of occupations were included in the series: physicians, lawyers, bankers, salesmen, teachers, editors, machinists, clerks, electricians, merchants, farmers, business executives and housewives. Thirty-seven of the patients stated that they had been able to resume the same work that they had done prior to operation. Forty-three were able to use the telephone, and 10 stated that they were able to address groups of people, some of them qualifying the statement with the word "small." Sixteen patients could sing before operation, but only 3 asserted that they could do any singing since laryngofissure.

I am now at work on a follow-up study of the postoperative appearances in the entire series, with a view to determining, if possible, what elements are participating in the voice developed in each particular case.

#### SPEECH AFTER LARYNGECTOMY

The patient who has had his larynx removed or is about to have it removed is apt to be depressed at the thought that he may never be able to talk again, but he will be cheered at once if one explains to him that the larynx is only one part of the speech mechanism, that it provides a column of air (coming up from the lungs) and a pair of vibrators (the vocal cords) but that it is the "molds of speech" (such as the tongue, lips, cheeks and palate) which form the words. Then one

TABLE 2.—*The Voice After Laryngofissure*

Patient	Sex	Age	Date of Operation	Have You Developed a Useful Voice?	Is Your Voice Good?	What Was Your Occupation?	Were You Able to Resume the Same Work?	Do You Talk on the telephone?	Do You Address Groups?	Did You Sing?	Are You Able to Sing Since Operation?	Comment
1. A. W. B.	F	40	10/27/36	Yes	Fair	Housewife	Yes	Yes	No	Yes	No	"The strength of my voice depends on general physical conditions."
2. M. B.	M	60	3/10/36	Yes	Fair	Carpenter	Pensioned	Occasionally	No	No	No	"My voice is a little above a whisper."
3. J. E. B.	M	62	1/ 9/34	Yes	Good	Executive and part time salesman	Yes	Yes	No	No	No	"I have gained weight (198 lb. [90 Kg.])."
4. S. F.	M	53	12/15/33	Yes	Fair	Hebrew teacher	No	No	No	Yes	No	"I am still unable to breathe freely."
5. J. G.	M	51	10/30/34	Yes	Fair	Farmer	Yes	Yes	No	Yes	No	"My voice is slightly low."
6. L. G.	M	49	7/25/33	Fair	Fair	Drill press operator	Yes, but not working now	Yes	No	Yes	No	-
7. P. L. J.	M	63	4/16/38	Yes	Fair	Retired medical officer, U. S. A., now director of hospital	Yes	Some	No	No	No	
8. G. U. H.	M	66	3/13/33	Not very good	Poor	Editor-publisher	Yes	Yes	No	Not much	No	"My voice has not shown improvement in the past several years."
9. G. K.	M	59	9/25/37	Yes	Fair	Salesman	No	No	No	No	No	"I have gained 11 lb. (5 Kg.)."
10. F. S. L.	M	62	9/27/35	Yes	Fair	Clerical worker	Yes	Yes	No	Yes	No	
11. R. W. Mc.	M	59	7/28/37	Yes	Good	Lawyer	Yes	Yes	In court work	No	No	"I have argued several cases and tried several cases with no ill effects. My voice varies; old friends say it is normal."
12. W. E. J.	M	53	11/ 5/38	Yes	Fair	Executive	Yes	Yes	No	No	No	
13. B. M.	F	53	1/ 7/31	Yes	Good	Government clerk	Yes	Yes	No	Yes	No	"My voice grows continually stronger."
14. C. M.	M	70	3/27/35	No	Poor	Lawyer	To a limited extent	Yes, whisper	No	No	No	"I use a whispering voice, which carries very well."
15. A. K. O.	M	58	12/13/30	Yes, in a quiet room	Fair	Assistant vice president of trust company	No	Yes	Occasionally, small groups (20 to 30)	Yes	No	
16. F. T. O.	M	61	10/23/36	Yes	Fair	Executive in charge of sales department	Yes	Yes, with special microphone attachment	No	No	No	"While the voice has improved constantly during the past 2 years, it has not reached a point where it is possible to carry on business conversations except in a quiet office. I have been in good health and work as hard as ever."
17. A. N. P.	M	57	10/27/37	Yes	Fair	Public accountant	Yes	Yes	No	Yes	No	
18. G. A. S.	M	73	3/30/35	Yes	Fair	County appraiser	Yes	Yes	No	No	No	"When I am talking on the telephone and have to repeat, it makes me nervous and short of breath. My voice is always hoarse, as though I had a bad cold."

19. J. G. S.	M	68	7/ 3/33	Yes	Fair	Executive	Yes	Yes	No	Yes	Yes	carry on tune, but volume is limited	I used my voice considerably "during business hours, especially for dictation, but conserve my voice during the evening."
20. J. B. S.	M	45	2/18/30	Yes	Fair	Machinist	Yes	Yes, with effort	No	No	No	No	"I can talk to a small group of people in a small quiet room, where a whisper can be heard."
21. T. B. W.	M	58	8/ 6/37	No	Poor	Farmer	Yes	Yes	No	No	No	No	"I think the operation was successful in my case. I am satisfied with my voice."
22. H. W.	F	56	9/28/31	Yes	Good	Housewife	Yes	Yes	No	Yes	Yes	No	"I can talk on the telephone if necessary but have never had occasion to do so since the operation. My voice is not strong enough to address groups of people."
23. E. W.	M	77	7/21/37	Yes	Fair	Sexton	Yes	No	No	Yes	Yes	No	"My voice is still rough and husky but gradually getting stronger."
24. M. B.	F	51	2/20/37	Yes	Fair	Housewife	Yes	Yes	No	Yes	Yes	No	"I do not answer the telephone if I can get out of it. My voice is not strong but much better than a whisper. I think it is gradually improving."
25. E. A. H.	M	63	11/ 7/33	Yes	Fair	Electrician	Yes	Yes	No	No	No	No	"I did much talking and dictation and telephone work before operation. Now I do work which does not necessitate much talking."
26. A. T. H.	M	76	9/ 4/36	No	Fair	Merchant	No	Yes	No	No	No	No	
27. H. C. H.	M	45	8/11/37	Yes	Fair	Clerk	No	No	No	No	No	No	
28. P. H.	M	60	11/ 8/32	Yes	Fair	Manager	Yes	Yes	Small groups	I thought so	No	No	
29. M. B.	M	62	3/28/32	Yes	Poor	Manufacturer	Retired	Yes	Yes, small	No	No	No	
30. L. L. D.	M	59	4/10/33	Yes	Fair	Colonel, U. S. Army	Yes, until retirement, in 1937	Yes, without trouble, long distance and local	No, except socially, in small room, in general conversation	No	No	No	"My voice enables me to get along well among strangers when traveling and among friends with whom I am associated. I cannot call to persons at a distance and have trouble in making myself heard by those in another room. Most persons do not notice my voice, although strangers now and then comment on my apparent hoarseness and ask about my cold."
31. C. H.	F	63	4/17/36	Yes, but low	Fair	Housewife	Yes	Yes	Small, in quiet room	No	No	No	"I have noticed a marked improvement in the last 2 months. I cannot talk over any sort of din or noise. I am in perfect health."
32. G. E. L.	M	53	5/ 8/30	Yes	Fair	Manufacturer	Yes	Yes	At small meetings	No	No	No	
33. R. N.	M	74	4/ 4/33	Yes	Fair	Manufacturer	Retired now but worked a while after operation	No, cannot be understood; voice is too low	No	No	No	No	"I am able to talk plainly to people in a room but cannot call or shout. There is mucus in my throat which I was not troubled with previously."
34. W. S.	M	52	5/21/34	Yes	Fair	Farmer	Yes	Have tried, but voice is too weak to be heard	No	No	No	No	"I cannot talk loud but can whisper distinctly. If I try to talk where two or three are talking my throat gets tired."



Table 2.—The Voice After Laryngofissure—Continued

Patient	Sex	Age	Date of Operation	Have You Developed a Useful Voice?	Is Your Voice Good? Fair? Poor?	What Was Your Occupation?	Were You Able to Resume the Same Work?	Do You Talk on the Telephone?	Do You Address Groups?	Did You Sing?	Are You Able to Sing Since Operation?	Comment
35. W. C. V.	M	54	1/12/34	Yes	Fair	Buyer and seller of merchandise	Yes, but voice has been a handicap	Yes	No	Yes	Yes, in a low tone; not much volume	
36. H. R. W.	M	71	6/ 7/32	No	Poor	Farmer	Handicapped	No	No	No	No	"My voice has improved very little since I left the hospital in July 1932. It is an effort and strain to talk so as to be understood."
37. H. L.	M	57	7/12/32	Yes	Fair	Lumberman	Yes	Yes	Small groups	No	No	
38. H. McD.	M	61	8/23/35	Yes	Good	Farmer	No, because of other ailments	Yes	Yes	A little	No	"My voice is much better than I thought it would be, and I can talk so that I can be heard by a group of people or a person in the same room. When I am speaking, though, my voice lowers at the end of every sentence. I am much pleased with the operation and grateful."
39. H. S. McK.	M	70	10/15/36	Yes	Fair	Office worker	Yes	Yes	Small groups	No	No	"About the first of the year (1939) I noticed it becoming increasingly difficult to talk in a normal way and developed an inclination to whisper; I am still doing this."
40. W. M.	M	17	7/ 3/34	No	Fair	Pharmacist	No	Yes	No	No	No	"Those who know and are used to my voice understand me over the telephone but the greater percentage do not. I was not able to resume the same work so far as the use of the voice is required."
41. L. P.	F	46	3/ 6/37	Yes	Fair	Saleswoman	No	Yes	No	Yes	No	"A recent examination by a local specialist showed no change in condition, and my voice is much stronger. After I have talked a great deal my throat feels tired; then whispering takes place."
42. A. A. S.	M	55	10/ 2/35	Yes	Fair	Industrialist	Yes	Yes	No	No	No	"I am able to talk on the telephone, but with difficulty."
43. H. B. T.	M	54	2/17/31	Yes	Good	Sales manager	Yes	Yes	Yes	No	No	"Some of my old friends maintain that my voice continues to become more normal, and I find, especially in making sales over the long distance telephone, that I have practically no trouble in making myself heard. I feel most grateful to you for what you have done to make it possible for me to carry on, hold the same position and enjoy good health."
44. H. E. W.	M	45	4/12/33	No	Fair	Head of production department	No	A little	No	No	No	
45. H. Y.	M	57	8/ 9/31	Yes	Fair	Window cleaner	Yes	Yes	Occasionally	No	No	"I find a definite improvement in my voice since my operation."

46. C. M.	M	60	9/28/38	Yes	Fair	Engraver	Yes	When necessary, but only fairly well	No	Not for about a year before	No	"My voice seems increasing in strength. Before operation I could speak only slightly above a whisper."
47. R. L. W.	M	50	13/11/31	Yes	Good	Manager of telegraph office	Yes	Yes	No	Yes	No; hesitate to put voice to test	"I feel that I have successfully used my voice in my work, meeting my public and using the telephone as my work calls for. My voice is improving all the time. I had a singing voice with a great deal of volume but not cultivated. I used it only for the pleasure of my family and friends. I have not been able to sing since the operation. Perhaps I could develop some sort of singing voice if I were not afraid of straining."
48. G. N. L.	M	47	9/25/37	Yes	Fair	At time of operation, Secretary of State for Foreign Affairs of _____; now, lawyer	Yes	Yes	Yes	No	No	"I was called on a few months after operation to make frequent public speeches to _____ Congress and was able to do so without any difficulty with the use of an amplifier. In the month of April 1938 I was able to speak in public without an amplifier but it was naturally a strain on my voice."
49. T. G.	M	53	10/20/33	Yes	Good	Salesman	Yes, to a large extent	Yes	No	No	No	"While my voice might be considered good it is, of course, not strong, and it is an effort to talk if there is any other noise or conversation going on. I cannot talk where machinery is in operation, but you advised me not to do that or to strain my voice; in a quiet room I have no difficulty at all. I can even talk to a person in the next room if there is no other noise, and I really feel that my voice is gradually getting stronger."
50. H. W.	M	61	4/22/37	Yes	Poor	Executive of shoe manufacturing company	Not to same extent	At times, but with more or less difficulty in being heard, for which reason I avoid it except when necessary	No	No	No	"I try to avoid meetings or groups that are noisy, as I find that trying to talk over noises requires some straining, resulting in irritation and more or less coughing. This condition is also caused if I talk too long at one time, even though it may not be necessary to raise my voice."
51. E. E. H.	M	51	3/11/33	Yes	Fair	Physician	Yes	Yes	With great difficulty; I am unable to speak loud	No	No	"In ordinary conversation my voice is husky and unmusical, but I get along satisfactorily. I cannot talk loudly enough to be heard over noises like a room full of people in conversation, nor can I talk to one across a room with comfort."

TABLE 3.—*The Voice After Laryngectomy*

Patient	Sex	Age	Date of Opera- tion	Have You Learned to Speak Without the Larynx?	Is Your Voice Good? Fair? Poor?	What Was Your Occupation?	Were You Able to Resume Your Work?	Have You Tried an Artificial Larynx?	Was it Satis- factory?	Comment
1. A. B.	M	54	3/14/35	Yes	Fair	Dealer in fruits and vegetables	Yes	No	...	"I was unable to resume work because no position is available because of my age. I could not talk fast anyway. I can carry on ordinary conversation comfortably."
2. W. I. B.	M	62	2/11/36	Yes	Good	Salesman	No	No	...	"I firmly believe that if I had not been so impatient and had let you work on my throat another day or two I should have been able to use my voice as I was doing before. I am as healthy as any one can be."
3. L. H.	M	66	4/ 6/34	No	Poor	Merchant and cotton ginner	Yes	Yes	Yes	"I was taught to use the 'pseudovoice' by Dr. Morrison of New York. My voice varies. Prolonged talking is an effort and makes me cough."
4. M. K.	M	47	1/24/33	Yes	Good	Grocer	* Yes	No	...	"I am extremely grateful, as the operation saved my life and returned me to useful work."
5. E. L. K.	M	54	5/13/36	Yes	Fair	Carpenter	Yes	No	...	"I should be a lot better if I could work. I feel well, if I only had a job to occupy my time."
6. F. W. K.	M	81	10/29/34	Yes	Good	Captain, U. S. N., retired	Retired	Yes	Fairly so	"I weigh more now than ever. I have never tried to talk too hard because it is too hard on the stomach of an old man."
7. J. H. L.	M	49	6/22/34	Yes	Good	Physician	Yes	No	...	
8. M. L.	M	56	9/ 8/30	Yes	Good	Laborer	No, unem- ployed	No	...	
9. P. K. L.	M	66	11/ 2/37	No	Fair	Stann and air fitter	Pensioned	No	...	
10. C. M.	M	66	6/ 1/34	No	Good	Molder	Worked 3 years	Yes	Yes and no	
11. L. N.	F	44	8/19/30	Yes	Good	Housewife	Yes	No	...	
12. Q. R.	M	65	10/ 1/36	No	Fair	Wood carver	Retired	No	...	
13. H. S.	M	65	1/15/37	Yes	Fair	Railroad engineer	No	No	...	"I use a whispered voice."
14. L. W.	M	58	6/10/38	Yes	Poor	Suitcase maker	Yes	No	...	"I imagine I could speak much better if I were able to swallow without its hurting me. It does not hurt to swallow food, only air."
15. F. Z.	M	67	12/ 1/31	Yes	Good	Magistrate	Yes	Yes	No	
16. E. D. B.	M	67	9/24/30	No,	Good	Worker in steel business	Retired	Yes	Very	"I tried the Bell Telephone larynx without success and have used the Voco-Phone, produced by McKesson Appliance Co., Toledo, Ohio, since June 1931. Any additional information you may wish will gladly be supplied. I worked all the time from June 1931 to Dec. 31, 1937."

17. J. H. C.	M	64	1/20/38	Very little	Poor	Printer	Was superintendent; now a compositor	No	...	
18. N. B.	M	57	11/23/31	Whisper	Poor	Tailor	No	No	...	"My voice is exceptionally good."
19. W. J. H.	M	53	12/28/37	Yes	Fair	Salesman	Yes	No	...	"I can be understood by those used to conversing with me, but most of my conversation is carried on by writing. I have never used an artificial larynx. My general condition is good."
20. M. M.	F	59	5/14/35	No	Poor	Housewife	Yes	No	...	
21. F. O.	M	70	1/22/37	No	Poor	Steel worker	Pensioned	No	...	
22. C. A. B.	M	51	7/14/31	Loud whisper	Fair	Hotel proprietor, 20 years	Only in a supervisory way	No	...	"As you remember, I told you before operation that I would come out of the operating room talking. I have not given up, and I am still trying, with the result that I have been able to carry on a conversation with persons who are around me often, so that they understand me very well."
23. G. C.	M	68	9/4/31	Yes	Good	President and owner	Yes	Yes, one time	Advised not to use it, since if I did I wouldn't learn to talk	"Dr. ——— looked at my throat this morning and said that it was all right and that I should tell you that my voice is good. I talk over the telephone and, while I think that I talk low, my voice seems to carry as persons upstairs can hear me from down stairs in the office (from 40 to 50 feet [12 to 15 meters])."
24. J. K.	M	59	12/20/37	Yes	Fair	Printer	Part time	No	...	
25. R. J. O.	M	49	7/19/32	Not very well	Fair	Waiter	No, working for city in small way	Yes	No	
26. J. P.	M	53	7/11/36	Yes	Fair	Unemployed	Unemployed	No	...	"I should speak much better than I do now if my voice did not escape through the opening left after the laryngectomy. I should be glad if you would help me in making my voice louder."
27. R. B. W.	F	56	11/4/30	No, only in a whisper	Poor	Housewife	Partially	Have Bell telephone artificial larynx but cannot use it owing to excessive discharge of mucus	No	"In the even climate of San Diego I am less subject to colds and pneumonia than in the East."
28. H. S.	M	47	2/1/39	Yes	Good	Milkman	Yes, but job taken by some one else	No	...	
29. S. H.	M	51	10/8/37	Yes	Good	Storekeeper	Yes	No	...	
30. T. McF.	M	54	1/24/39	Yes	Fair	Painter	Unemployed	No	...	

explains that it will be necessary for him to learn to collect air in his hypopharynx, esophagus and stomach to replace the air column from the lungs and to produce tone by means of vicarious cords formed in the hypopharynx or pharynx. He will probably be skeptical about this, but one can assure him that experience has shown how to help patients get the knack of this sort of speech and that his course of voice lessons will be begun as soon after the operation as healing permits. I believe that the material presented in the tables published herewith will afford considerable help in reassuring patients about to have laryngectomy done. Schall<sup>8</sup> has published two excellent papers on the subject. He stated, "The laryngectomized patient is not a social outcast, nor in most cases is he an economic burden." He has found that such patients constitute "a most optimistic, cheerful group, neither objects of curiosity nor, in most cases, recipients of charity."

These views regarding the social and economic rehabilitation of the laryngectomized patient are fully supported by the replies to the questionnaire which was sent out in this study. At the present time I have had replies from 30 patients operated on during the ten years, and of these 18 replied "Yes" to the question "Have you learned to speak without your larynx?" Five stated that they could whisper; only 6 said flatly "No." One of the most interesting things noted in the replies to the questionnaires was the fact that in reply to the question "Is your voice good, fair or poor?" 50 per cent of the laryngectomized patients replied "good," while only a little over 10 per cent of the patients submitted to laryngofissure replied "good," most of them saying "fair." The patients who had laryngectomy, classified as to occupation, were: salesmen, merchants, carpenters, army officers, physicians, laborers, steam fitters, molder, housewives, locomotive engineer, wood carver, magistrate, executive, printer, tailor, hotel proprietor, waiter, gate tender and milkman. Seventeen of these patients have been able to resume the same work, wholly or partially. Among the questions asked the laryngectomized patients was whether or not they had tried to use an artificial larynx and whether it had proved satisfactory. Only 8 had tried it, and only 2 found it satisfactory—1 other said "fairly so" and still another "yes and no."

Morrison<sup>9</sup> deserves a great deal of credit for the work he has done in advocating a definite course of vocal instruction for laryngectomized patients. Some do not require lessons, but others make little progress

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8. Schall, L. A.: (a) *Psychology of Laryngectomized Patients*, Arch. Otolaryng. **28**:581 (Oct.) 1938; (b) *Laryngectomy*, Pennsylvania M. J. **41**:261 (Jan.) 1938.

9. Morrison, W. W.: *The Production of Voice and Speech Following Total Laryngectomy*, Arch. Otolaryng. **14**:413 (Oct.) 1931.

or develop hopelessly bad habits if they are not systematically taught. I first became interested in the subject when a patient from the clinic with which I am associated, who had considerable difficulty in learning to talk even after he had thoroughly grasped the fundamental principles of buccoesophageal speech, consulted Dr. Morrison, undertook a course of lessons with him and at once began to improve. Since then it has been the practice to have the patient begin voice lessons in each case as soon as the condition of the wound permits, and Dr. N. M. Levin, a member of the staff of the clinic, who has been particularly entrusted with this work, has been obtaining excellent results. I plan now to communicate with all those who have stated in their reply to the questionnaire that they have not been able to develop a satisfactory voice, requesting that they come in for instruction.

It is planned also to examine the entire series of patients with a view to determining what anatomic factors, if any, influence the voice. I have seen in some cases a "pseudoglottis," resembling the true glottis to a remarkable extent, while in other patients, having an equally good voice, it is difficult to ascertain what the vibrating structures are. There has been some question as to the advisability of leaving the epiglottis, with the idea that it might aid in the development of a voice. Personally I think this an unwise practice, because of the danger of incompleteness of removal of the tumor. As a matter of fact, I doubt the essential value of the epiglottis as a vibrator, because I have observed equally good voices in patients from whom the epiglottis had been removed.

With regard to the artificial larynx, I believe it is a mistake to have the patient try it before he has had a chance to develop a buccoesophageal voice. I believe its use should be reserved for those who are not able, after a fair trial, to develop this more natural "pseudovoice."

#### CONCLUSION

1. After direct laryngoscopic operations for the removal of benign tumors, the voice should, except in special cases, be restored to normal clarity.

2. Nodules of the vocal cords should be carefully removed by direct laryngoscopic procedure (or by indirect laryngoscopic procedure if preferred) ; however, in cases of professional singers it is perhaps best to try first a period of vocal rest and special exercises.

3. While voice is of secondary importance in procedures undertaken for the eradication of a malignant tumor, the reply to a questionnaire sent out to a series of patients who had had laryngofissure or laryngectomy for cancer of the larynx showed that the majority had been able to develop useful voices and to resume their original occupations.

4. The majority of the patients who had developed a voice after laryngectomy considered it "good," while the majority of patients who had had laryngofissure considered their voices only "fair."

5. While many patients acquire spontaneously the knack of buccoesophageal speech, it is best to give laryngectomized patients a systematic course of voice lessons, as advocated by Morrison, just as soon as the wound is healed.

6. The artificial larynx should not be tried until after the patient has made some effort to develop a voice without it.

#### DISCUSSION ON PAPERS IN SYMPOSIUM ON VOCAL DEFECTS

DR. WALTER H. THEOBALD, Chicago: I am wondering, in connection with the effect of faradic current applied to the neck, if Dr. Mithoefer knows that in an experiment at the Research Hospital by Dr. Fischmann and myself in no instance, in dogs or in man, were we able to record any change in the vocal cord whatsoever when faradic stimulation was given on the outside to any of the nuchal muscles.

I wonder if the effect is not, after all, psychic. It is known that when a person chins himself, pulling himself up by a handle bar, and uses the voice, it is promptly elevated.

I had hoped that Dr. Mithoefer would touch on the subject of a posterior chink in the cord that is lax and bowed. I should like to report to him that I have observed 6 cases now in which a posterior chink was present and weakness in the voice resulted from it and the escaping air. I found the 6 patients to have a low metabolic rate, varying from —16 to —26 per cent, and in each case by merely treating the patient with thyroid the posterior chink was closed.

DR. AUSTIN A. HAYDEN, Chicago: The large class of persons, it seems to me, that need vocal training or, at least, vocal improvement are generally not handled by the specialists in vocal improvement. They are the persons that do not hear well and that have lost some of the normality of their voices because they cannot hear themselves talk with perception of all the tones and therefore cannot control their voices satisfactorily to themselves and to the persons that hear them.

This is, of course, an ever present problem with any one who has much to do with hard of hearing persons.

DR. BURT R. SHURLY, Detroit: The work in the public school system in Detroit has been developed in a marvelous way. One of the first of the departments teaching tones to those with defects in speech was established, with the school for the deaf and the department of speech defect working harmoniously in cooperation and in consultation and then carrying on in the school system an extensive test for loss of hearing among the school children. The 12,500 children examined showed a 4.8 per cent loss of hearing.

Now, if such patients are to be reached it must certainly be in the early years of life. I feel that a widespread general examination for defects of hearing through the great school systems of the country would bring to the otologist many patients with such defects in the earlier years of life, during which there is some hope of doing something for them. The difficulties that arise after the troubles have continued for some time are well known.

DR. LOUIS H. CLERF, Philadelphia: I should like to ask Dr. Mithoefer if this faradic current therapy would be useful for disorders due to the excessive use of the larynx. Does he use the faradic current in the treatment of such disorders?

DR. HAROLD I. LILLIE, Rochester, Minn.: In many cases the vocal fatigue Dr. Mithoefer has talked about, as he has suggested, is from the wrong use of

the voice. There are certain persons who need to do considerable public speaking and try to force their voices beyond their natural capacity, and they get no relaxation. There is tension. If they would lower their voices, they would get complete relaxation, and their voices would carry miles.

DR. JAMES S. GREENE, New York: In New York there is a League for the Hard of Hearing. I thought it would be a good idea to let the league take care of the persons who do not hear well. Therefore, Dr. Hayden will have to talk to Dr. Voorhees about the hard of hearing persons. Dr. Theobald wanted to know about treatment. It is rather difficult to tell what my colleagues and I do, but I have invited Dr. Theobald to come to New York to our clinic. I extend this invitation to any member here. We have no secrets. We are only too glad to show and tell what we do.

DR. IRVING WILSON VORHEES, New York: Mucous nodules can be cured by rest and by vocal exercise, but about fibrous nodules I am doubtful, although occasionally I find a singing teacher who says he can cure any patient with vocal nodules through exercises and once in a while a physician believes that that is true. My own feeling is that it is about as difficult to sing a nodule off a vocal cord as it is to walk a corn off a toe.

DR. WILLIAM MITHOEFER, Cincinnati: I can't conceive of a psychic element in the treatment of phonasthenia with electrophonic compensation, because physiologically it is known that the note rises when the application is made. The posterior chink in the vocal cord of a hypothyroid patient probably is there because of mild infiltration. I am a great believer in giving a systemic treatment, if necessary, to singers, and if they do not improve after several treatments, I do not depend on the basal metabolic rate but depend on the afternoon temperature, between 4 and 6. If it is subnormal, especially if it is recorded for a week, I always advise thyroid medication, beginning with a small dose and increasing slowly until the afternoon temperature is normal or the pulse rate rises to 95.

DR. JAMES S. GREENE, New York: It seems to me that Dr. Mithoefer does not fully realize, at least the way I see it, the interrelation between the psychic and the somatic, in other words, the "physiologizing" of the emotions.

The mere fact that the physician applies his little instrument is enough stimulus to change the patient psychically. I have seen that again and again. Dr. Voorhees will bear me out that on Friday or Saturday he talked to a patient who came to my clinic from Minneapolis. The patient had great difficulty with his speech, and he had had colitis for five years. He came to the clinic, and the only thing I asked him to do was to stop all treatment for his colitis while he was taking the speech treatment. Saturday he went home. He is speaking beautifully, and his colitis is absolutely cured, which indicates the "physiologizing" of the emotions.

The physician deals with temperamental persons, subject to elation and depression, so much so that I have taken it on myself in recent years not to call the condition phonasthenia any more. I have changed the name. I call it psychophonasthenia. The most important phase in such cases is the psychic.



# DEFECTIVE SPEECH IN RELATION TO DEFECTIVE HEARING

MAX A. GOLDSTEIN, M.D.

ST. LOUIS

Perfect speech is dependent on perfect hearing, correct voice production, understanding of pitch, volume and rhythm control and careful articulation.

It is a reasonable and logical observation that defective speech is often the result of imperfect hearing. Speech in its essence and performance is but an imitation of the sounds of the human voice as heard.

Defective hearing may be the main factor in many cases of speech defects, notwithstanding good voice and careful articulation. A lack of physical appreciation of pitch, volume and rhythm, due to defective hearing, may counteract all favorable elements in the production of perfect speech.

Speech is the most constant and universal instrument of exchange in the social contacts of man with man; it is the one fundamental act that distinguishes the human being from brute creation; it is a vital element of social intercourse; it is the most useful and frequent form of expression of thought; it is the principal factor in advancement and success; it is the keystone of emancipation from many handicaps.

There are so many details to be considered in the discussion of speech and its defects that only a few features may be touched on in this short survey.

Voice is sound originated in the larynx and may be produced by any animal possessing that organ.

Speech is voice modified in the cavity of the mouth by changes in the size and shape of this cavity, controlled by the mechanism of articulation, comprising the tongue, teeth, lips, velum and mandible.

As speech is dependent on normal hearing for its perfect production, the model of speech must be perfect. If the model is imperfect and the hearing imperfect, the resultant speech will be imperfect.

There is an interesting story or legend ascribed to the Chinese: Some centuries ago a mandarin ordered a normal-hearing young child, before speech had been established, to be placed under the supervision of mute attendants on a deserted island. According to the story, this

child grew up and throughout adolescence, notwithstanding his normal hearing, was unable to speak.

Among disorders of speech of childhood, the outstanding and most frequently to be considered etiologically associated with defective hearing is dyslalia, also known as oral inactivity, or, more commonly, as "baby talk." Dyslalia is defined as "Impairment of utterance with functional abnormality of the external speech organs" and includes a great variety of articulatory defects.

In the examination of many patients the origin of such defects can be traced to imperfectly heard speech patterns or imitation of fond mothers and relatives who coo and distort their own speech for the child's and their own amusement, little realizing that they are setting an example and offering every possible opportunity for the development of this prevalent speech defect. In addition to this, it may be observed in passing that the parents of such a child frequently consult a pediatrician about the prospects of correcting this defect, only to be told by him, "Don't worry, Mrs. Smith, your child will outgrow it."

The second chapter in the program of dyslalia (baby talk) is frequently ushered in by the appearance of acute stammering.

Speech correctionists refer constantly to dyslalia as a frequent forerunner of stammering.

Another but less common etiologic factor in speech defects is word deafness, a central disturbance of the auditory center in the cortex, in which sounds are heard but convey no meaning to the child.

In describing the speech centers the Wernicke center is referred to as the speech-hearing center and the Broca center as the speech-producing center. In word deafness, therefore, the Wernicke center may be delayed in development, or its relation to the Broca center by association fibers may be impaired.

In young children both dyslalia and word deafness are thoroughly amenable to correction in the hands of expert speech correctionists.

In the later nomenclature, the congenitally deaf child has been constantly referred to as the "deaf-mute." This has been a general and all-inclusive term that has been applied throughout the ages to persons with almost every form of deafness, congenital or acquired, in which the social and economic helplessness of the affected person has been complicated by inability to speak. Even in the present era of better understanding and oral training for the deaf, the term "deaf-mutism" is still applied more or less indiscriminately.

Congenital deafness of the profound type (with no residuum of hearing) and congenital mutism rarely occur simultaneously. It has been my experience that congenital mutism per se is extremely rare.

With the advent of methods of oral instruction by which the young congenitally deaf subject can be taught the mechanics of rhythm, pitch,

accent, volume and quality of speech by the application of sight and touch as a substitute for the lost sense of hearing, the claim is now justifiable that every congenitally deaf child has the potentiality of speech. All that is required is the opportunity for such instruction under the guidance of specially and properly qualified teachers.

Another defect in speech which accounts for a large class of physically handicapped children is stammering and stuttering. Psychology and pedagogy have emphasized the significance of heredity and environment as causal factors in these speech defects. The clinical and otolaryngologic examinations that are a routine in speech clinics devoted to the correction of stammering in children demonstrate that sizable numbers of such children have substantial mechanical defects in the nasal or the oral cavity. Even in this rabid age of indiscriminate tonsillectomy one finds surprisingly large numbers of patients in such clinics with enormously hypertrophied faucial tonsils and adenoids, in addition to those with nasal obstruction due to marked septal deflection, turbinal occlusion or chronic sinusitis.

It is unnecessary to discuss before the American Laryngological Association the physical obstructions to which such pathologic conditions may lead as far as hearing is concerned. It is the practice to include in a complete clinical inspection an individual audiogram and both Weber and Rinne tests with the tuning forks. The results show corroborative evidence of defective hearing in varying degrees, often incapacitating the pupil for acceptable scholarship in the normal classroom.

Even when the tonsils and adenoids have been expertly removed there may be recurrent lymphoid tissue in both the posterior and the lateral part of the nasopharynx, interfering with the normal functions of the eustachian tube and sometimes even affecting the labyrinth by low grade toxic absorption.

The care of the child with such a condition may be classified distinctly as preventive medicine, and in connection with this thought I offer the observation that many of the group surveys of school children have been substantial factors in establishing deafness as a cause of speech defects. The survey, however, cannot be considered complete without the follow-up.

To cite one of many cases in question: In the course of an individual clinical examination a child is found who reveals hypertrophied or diseased tonsils, recurrent adenoids or nasal obstruction of a character that leads the otolaryngologist to conclude that the hearing or even the general health of the child warrants surgical intervention. Recommendation is made to the parent through the school physician or school nurse that the child should be taken to a laryngologist or visit a laryngologic clinic for such operative service. The unfortunate hitch

in this procedure is the objection of the parent, either through ignorance or through aversion to operation. It has been frequently reported by the school nurse or school physician that the parent is adamant to these suggestions. There is no law of school, municipality or state that can compel a parent to accept such advice, and the parent is thus placed in the unenviable position of acting as an obstructive influence to the health and future of his own child.

Much educational stimulus may be given by the laryngologist concerned with the welfare of the school child by appearing before mothers' groups and parent-teacher associations and explaining the significance and importance of these problems.

Another practical observation to be cited in connection with defective speech in its relation to defective hearing is the case of the deafened adult whose speech quality, articulation, pitch and volume suffer materially when his hearing becomes so defective that he is unable to hear his own voice distinctly and is therefore unable to make the necessary correction of these various speech deficiencies.

Surveys that have been instituted in school systems throughout the nation, stimulated and developed by otolaryngologists, have had many important and far-reaching results and have awakened the larger communities to the significant fact that over 3,000,000 of the 50,000,000 pupils enrolled in the public school systems of the United States of America have imperfect hearing and 4,000,000 demonstrate some defect in speech. These defects range from slight to serious handicaps. When as many as 14 per cent of the future citizens of a vast nation show defects in speech or hearing, a large percentage of which can be definitely and permanently corrected, it becomes not only a question in which otolaryngologists and physicians are concerned but also one in the careful study of which every vital agency of the nation must be interested.

It is a frequent observation that Americans have inherited the English language as one of their most splendid assets from the English people and an equally frequent and justifiable criticism that they have distorted and often destroyed this asset by the introduction of slang, vernacular and slovenly speech.

If more care and attention were given to the development of oral English for the benefit of the rising generation, I venture the thought that some of the less potent cultural elements that have been injected into the school curriculum could well be dispensed with.

I think enough has been said in this brief paper to justify the conclusion that the problem here considered is vital and that it is distinctly the province of the laryngologist to clarify the attitude of the parent, to emphasize proper surgical treatment in the individual case and to create a better understanding of the principles of preventive medicine.

## DISCUSSION

DR. GEORGE B. WOOD, Philadelphia: I have heard of two children of early age who were deserted by their parents and allowed to run wild. They developed a language sufficient for communication with each other.

DR. GORDON BERRY, Worcester, Mass.: There is one brief thought that I might contribute in connection with Dr. Goldstein's statement that some children who needed surgical procedure could not have it done because the parents would not permit. The legal phases come in there. If the help of a probate judge is secured and the condition is one of real emergency, the purpose can be accomplished.

DR. BURT R. SHURLY, Detroit: The relation of speech to hearing suggests one of the great works that are being done in Detroit. The school system established one of the first speech correction departments in the United States. It has been remarkably successful and is becoming more and more fully appreciated by parents.

A resolution was introduced at a meeting of the American Medical Association asking for the encouragement and support of the medical profession in the endeavor to test children for defective hearing. In the last 12,500 tests performed by representatives of the board of education and the board of health of the city of Detroit 4.8 per cent of the subjects were found to have defective hearing.

As the relation of the nose and throat to many defects of speech and hearing is so important from the standpoint of laryngologists I would make a plea for a nationwide testing of school children. Dr. Goldstein has brought out that three million children are handicapped by such defects. The work is necessary if these physically handicapped children are to be educated. It is a great expense to a board of education to look after children who cannot see properly, are not properly fitted with glasses, cannot hear or have tonsils and adenoids that should be removed.

I believe that the rise and fall of popular opinion shows a need for a little reeducation, because the pendulum swings, as interest in many other ideas swings in America. Those who are interested in the administration of boards of education feel keenly that the backing of the medical profession is needed to give parents a better idea of the importance of the physical handicaps of children.

It is necessary only to speak of some of the education against operation to make me feel that all laryngologists should get together again and develop the care of the handicapped child that their specialty is concerned with.

Recent reports by Dr. Crowe and his associates show that definite loss of acuity of hearing for the higher frequencies (i. e., 4096 and 8192 double vibrations) often occurs in young children as the first indication of a conductive impairment of hearing due to obstructive lymphoid hyperplasia in and about the eustachian tubes. This is contrary to traditional teaching. In view of these findings it seems important to consider a revision and refinement of the technic for the early detection of deficiencies in hearing in children.

In many communities the 4-A or 4-B Western Electric phonograph audiometer or its equivalent has been extensively used to disclose deficiencies in hearing in school children by a screening process covering all pupils old enough to write dictated numbers. In two states, New York and Pennsylvania, its use is mandatory. It has recently been found by G. Oscar Russell, Ph.D., of the University of Ohio, at Columbus, Ohio, and by others that this test does not disclose deficiencies of hearing for the higher tones.

I would suggest, therefore, that the younger groups of school children be individually tested with a simple, accurate, quickly operated, pure tone, or pitch range, audiometer, such as has lately been made available at a low price. A preliminary trial by this method in the public schools of Minneapolis has disclosed a surprising number of children in the lower grades, not revealed by the usual tests, who have losses of hearing for the higher frequencies and who should have otologic scrutiny.

Yesterday in its business meeting the American Otological Society, following the example of the Section on Laryngology, Otology and Rhinology of the American Medical Association and other organizations, adopted a resolution to encourage and promote the granting of funds by foundations and appropriate agencies to make possible surveys, especially in rural areas, for the discovery of children who have or are threatened with defects in vision, hearing or speech and, in the case of the underprivileged and indigent, to provide corrective treatment through the cooperation and leadership of qualified physicians who are members of national, state and local medical societies.

I respectfully urge that because of the laryngologist's broad interest in the interrelation of speech and hearing, so ably brought out by Dr. Goldstein, a similar resolution should be adopted at the business meeting of the American Laryngological Association.

DR. WILLIAM E. GROVE, Milwaukee: Mr. Chairman, Dr. Goldstein spoke of the prevalence of enormously enlarged tonsils and adenoids in connection with the problem he discussed. Now that tonsillectomy and adenoidectomy in most parts of the country are performed not by otologists, rhinologists and laryngologists but by general practitioners and surgeons, poor operative work is being done. The tonsils are still pulled out with some success, although one sees all sorts of injuries to the pillars, the soft palate and other structures and many times the soft palate and the pillars are removed and the tonsils are left in.

To my mind, the most poorly performed operation in the field of laryngology is adenoidectomy. I am sorry to say that my statement includes some of the operations performed by laryngologists and certainly all of those performed by general practitioners who attempt to take the enlarged adenoid tissue out. I think a great deal of education in the proper performance of adenoidectomy should emanate from otolaryngologists.

DR. WILLIAM B. CHAMBERLIN, Cleveland: I merely wish to emphasize the thought that Dr. Shurly has expressed in regard to the universal examination of school children.

DR. THOMAS E. CARMODY, Denver: Whenever I operate for cleft palate I invite my confreres and pediatric friends to view the adenoid area. If they see where the adenoids are located, better work may be done.

DR. MAX A. GOLDSTEIN, St. Louis: I think Dr. Shurly sounded the keynote for the future and indicated the responsibility of the laryngologist in the rather important phase of development and improvement of the physical condition of the school child which has been discussed by referring to and emphasizing the importance of getting a change in the trend of public opinion. After all, it is public opinion that sways almost every large movement in a big nation. Not only closer cooperation by laryngologists is required but better understanding of the problem of the laity.

Incidentally, I might disclose a little secret, that the reason or one of the reasons (and let me say this without much ego) that the Detroit public school

system has shown such a splendid front in dealing with this problem is that until about three years ago every teacher of the day school for the deaf in Detroit had passed through the hands of my colleagues and me in the Teachers' Training College of Central Institute and was qualified as a teacher of the deaf and a teacher of speech correction. The results depend largely on the qualification of the teachers.

The suggestion made by Dr. Berry is worthy of further development. I am really seriously concerned as to how to go about getting better cooperation from parents. If it can be done by legal procedure or some other persuasive act, as the temporary appointment of a guardian to see that the suggestions of the laryngologists are carried out in cases in which it is vital and in which further defect in hearing and in speech can be prevented, it will be excellent.

# RELATION OF ALLERGY AND TONSILLECTOMY IN CHILDREN

## INCIDENCE OF RESPIRATORY ALLERGY IN CASES OF ROUTINE TONSILLECTOMY

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AND

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The otolaryngologist, the pediatrician and the general practitioner are frequently confronted with the problem of diagnosis and treatment in cases of recurrent colds, sinusitis, bronchitis and recurrent pneumonia in children. These conditions are generally considered as infectious, and the treatment usually consists of the administration of cold "shots," drainage of sinuses or the removal of the tonsils and adenoids. That these symptoms and signs may be of allergic instead of infectious origin has been emphasized by Piness and Miller, Cohen and Rudolph and Hansel. The allergic nature of these complaints is often not recognized until frank bronchial asthma develops.

Piness and Miller<sup>1</sup> pointed out that allergy alone may produce chronic nasal obstruction without sneezing, unassociated with enlarged adenoids, and may cause frequent attacks of rhinorrhea and nasal obstruction in no way related to infection, although often designated as colds or sinusitis. Allergy may also cause persistent sore throat unrelated to tonsillitis and stuffy ears unrelated to pharyngitis. A chronic or intermittent cough without infection of the bronchi and with absence of dyspnea and wheezing, or recurrent bronchopneumonia with fever and leukocytosis and without wheezing and the presence of pneumococci may also result from allergy. In other words, Piness and Miller emphasized that allergy may simulate many of the symptoms and signs of acute or chronic respiratory infection.

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From the Department of Otolaryngology, Washington University School of Medicine.

1. Piness, G., and Miller, H.: Allergy of the Upper Respiratory Tract in Infancy and Childhood, *J. A. M. A.* **113**:734 (Aug. 26) 1939.



It has been pointed out by Cohen and Rudolph<sup>2</sup> and by Hansel<sup>3</sup> that the commonly occurring conditions of the respiratory tract in children should be considered as one of the following types: (1) allergic, (2) infectious or (3) combined allergic and infectious. The symptoms in all three types are often similar; hence differential diagnosis depends on careful clinical and laboratory investigations. In table 1 are listed

TABLE 1.<sup>2</sup>—*Differential Diagnosis of Allergic and Infectious Conditions of the Upper Respiratory Tract in Children.*

History	
Allergic	Infectious
<ol style="list-style-type: none"> <li>1. Attacks usually recurrent</li> <li>2. Often mild symptoms between attacks</li> <li>3. Definite relation to heredity</li> <li>4. Not contagious</li> <li>5. Not related to exposure to another case</li> <li>6. Constitutional symptoms slight</li> <li>7. Foods and inhaled substances often traced as causes</li> <li>8. Itching common</li> <li>9. Wheezing common</li> <li>10. Other allergic conditions present or in past history</li> </ol>	<ol style="list-style-type: none"> <li>1. Attacks usually single</li> <li>2. Usually clears up completely</li> <li>3. No relation to heredity</li> <li>4. Contagious</li> <li>5. Definite relation to exposure to another case</li> <li>6. Constitutional symptoms more marked</li> <li>7. No relation to foods or inhaled substances as cause</li> <li>8. No itching</li> <li>9. No wheezing</li> <li>10. Usually no other allergic condition present or in past history</li> </ol>
Examination	
Allergic	Infectious
<ol style="list-style-type: none"> <li>1. Visible mucous membranes pale, glistening, edematous</li> <li>2. Thin, watery, mucoid nasal discharge; mucous sputum</li> <li>3. Smear shows eosinophils in large numbers</li> <li>4. Other signs of allergy often present</li> <li>5. Sinus involvement of edematous type</li> <li>6. Wheezing breath sounds</li> <li>7. Roentgenogram shows bronchial markings increased</li> <li>8. Allergic skin reactions usually positive</li> </ol>	<ol style="list-style-type: none"> <li>1. Visible mucous membranes, hyperemic, red</li> <li>2. Mucopurulent or purulent nasal discharge or sputum</li> <li>3. Smear shows polymorphonuclear neutrophils as predominant cell, eosinophils few or absent</li> <li>4. No other signs of allergy</li> <li>5. Sinus involvement of purulent type</li> <li>6. No wheezing breath sounds</li> <li>7. Bronchial markings not increased in roentgenogram</li> <li>8. Allergic skin reactions usually negative</li> </ol>
Treatment	
Allergic	Infectious
<ol style="list-style-type: none"> <li>1. Epinephrine specific for asthmatic symptoms</li> <li>2. Avoidance of specific allergens followed by relief</li> </ol>	<ol style="list-style-type: none"> <li>1. No relief from epinephrine or ephedrine</li> <li>2. Avoidance of food or inhaled substances produces no change</li> </ol>

the differential points of allergic and infectious conditions as reported by Cohen and Rudolph.

The combined allergic and infectious type is frequently difficult to diagnose at the first observation. Acute and chronic infections may obscure the allergic phase of the condition.

2. Cohen, M. B., and Rudolph, J. A.: Allergic and Infectious Conditions of the Upper Respiratory Tract in Children: Differential Diagnosis, J. A. M. A. 97:980 (Oct. 3) 1931.

3. Hansel, F. K.: Allergy of the Nose and Paranasal Sinuses, St. Louis, C. V. Mosby Company, 1936.

The incidence of respiratory infections during the first five years of life was investigated by McLean.<sup>4</sup> A group of 156 children was studied. Fifty-one of the patients were subjected to removal of the tonsils and adenoids. It was found that this procedure had little or no influence on either the number or the severity of respiratory infections. The average incidence of colds in the entire group was 8.04, and the average period between colds was one hundred and eighty-one days.

An extensive investigation of the relation of the tonsils and adenoids to infection in children was conducted by Kaiser.<sup>5</sup> His observations were based on a control study of 4,400 children over a ten year period. It was concluded that the removal of the tonsils and adenoids favorably influenced the incidence of head colds. The incidence among tonsillectomized children was 22 per cent, as compared with 31 per cent for the controls. On the other hand, the incidence of bronchitis was somewhat increased among the children who had the tonsils and adenoids removed. It was also noted that pneumonia occurred more frequently in this group. The effect of the operation also had an unfavorable influence as far as sinusitis was concerned, for it was noted that first attacks of sinusitis occurred somewhat more commonly in these children.

In the evaluation of statistical studies on the incidence of respiratory infections in children, emphasis should be placed on the importance of excluding or taking into consideration those patients who have allergic respiratory symptoms which simulate the infectious type. Definite statistical error is evident if allergic patients are considered as having infection. Children with nasal allergy, allergic involvement of the sinuses, allergic bronchitis and allergic pneumonia will not be favorably influenced by tonsillectomy.

As patients are often seen for the first time when the symptoms are more pronounced, it is always a question whether the acute exacerbation is allergic or whether it is an acute, subacute or chronic infection. Repeated observations of the patient with especial reference to the cytologic character of the secretions may be necessary in all cases before an accurate diagnosis can be established. It must be definitely determined, therefore, whether the respiratory condition is allergic, infectious or allergic complicated by acute or chronic infection.

Unless a definite plan of investigation is followed in these cases errors in diagnosis are likely to occur.

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4. McLean, C. C.: The Incidence of Respiratory Infection During the First Five Years of Life, *Arch. Pediat.* **49**:279, 1932.

5. Kaiser, A. D.: The Relation of Tonsils and Adenoids to Infections in Children, Based on a Control Study of Forty-Four Hundred Children Over a Ten Year Period, *Am. J. Dis. Child.* **41**:568 (March) 1931.

In the management of respiratory infections in children, removal of the tonsils and adenoids is perhaps the procedure most commonly advised. It is most important, however, to separate the cases of respiratory allergy from the group of infections. Among the children observed routinely at the clinic of the Washington University School of Medicine for consideration of removal of the tonsils and adenoids, we have been impressed with the high incidence of respiratory allergy. In order to obtain some idea of the relative incidence of allergy in this group, we made a special analysis of 200 consecutive routine cases. The patients were observed during July, August and September 1938. Of the 200 patients 104 were boys and 96 girls. The ages varied from 3 to 16 years (table 2 and chart).

Of the 200 patients, 26 proved to have nasal allergy, an incidence of 13 per cent. Of the 26 patients with this condition, the local nasal symptoms were typical in only 13 instances. The complaints in all 26 cases are listed in table 3.

A positive family history of allergy was noted in 11, or 42 per cent, of the 26 cases, as follows: asthma, 6; hay fever, 3; asthma and hay fever, 1, and nasal allergy, 1.

A positive (past) history of other manifestations of allergy preceding the onset of nasal symptoms was obtained in 5 instances. Three patients had urticaria, and 2 had eczema.

In the local examination of the nose, it is noteworthy that only 14, or 54 per cent, of the patients with nasal allergy showed typical pallor or edema of the nasal mucosa. It is apparent, therefore, that diagnosis often cannot be established on the basis of the local changes.

In the 26 cases of nasal allergy the final diagnosis was based on the demonstration of eosinophils in the nasal secretions.

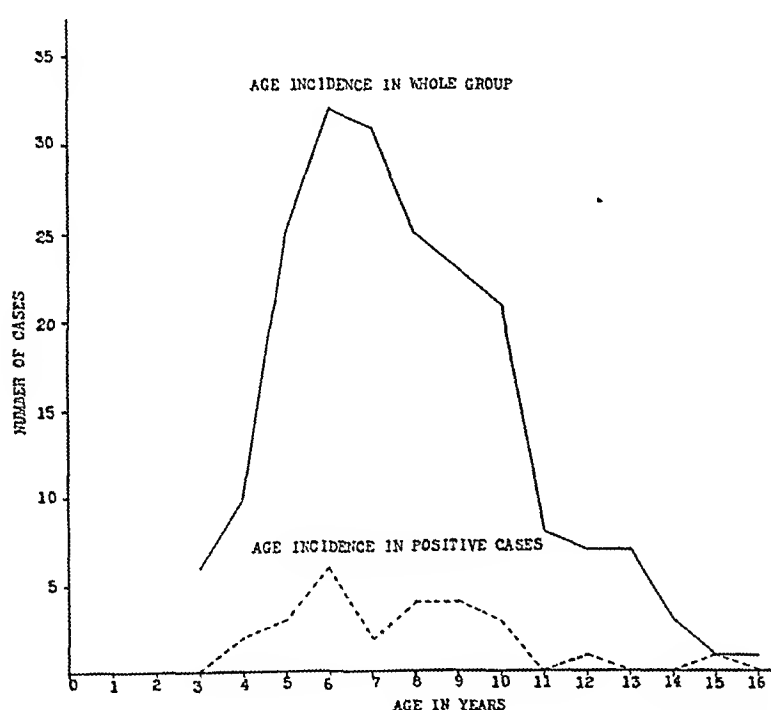
It is also noteworthy that 6 of the 26 patients had hay fever—3 due to grass and 3 to ragweed.

Of the group of 174 patients without nasal allergy, a positive family history of allergy was noted in 43, or 24.7 per cent. A positive past or present history of other forms of allergy was obtained in 18 instances, as follows: urticaria, 14 cases; eczema, 3, and eczema and urticaria, 1. In cases of other manifestations of allergy it is important to keep the patients under observation from time to time for the possible development of respiratory allergy. This is especially true of very young children, as respiratory allergy may be precipitated after an acute infectious disease, especially pertussis.

Of the 26 patients with nasal allergy 17, or 65.3 per cent, had already had an acute infectious disease (table 4).

TABLE 2.—*Age Incidence in 200 Cases of Respiratory Allergy*

Age, Yr.	Number in Entire Group	Number in Group with Nasal Allergy
3.....	6	0
4.....	10	2
5.....	25	3
6.....	32	6
7.....	31	2
8.....	25	4
9.....	23	4
10.....	21	3
11.....	8	0
12.....	7	1
13.....	7	0
14.....	3	0
15.....	1	1
16.....	1	0
Total.....	200	26



Age incidence in 200 cases of nasal allergy. In the chart, the number of cases in each age group from the group as a whole is indicated by a solid line; the number of cases of nasal allergy in each age group by a broken line.

In 1925 a survey of 840 allergic persons, mostly children, made by Piness and Miller<sup>6</sup> showed that the tonsils had been removed in 340, or 40 per cent. In 1938 a similar survey showed that of 2,230 allergic children 751, or 33 per cent, had had the tonsils removed. The combined reports of Cunningham,<sup>7</sup> Hansel,<sup>3</sup> Clarke and Rogers<sup>8</sup> and Waldbott,

6. Piness, G., and Miller, H.: Allergy: A Nonsurgical Disease of the Nose and Throat, J. A. M. A. **85**:339 (Aug. 1) 1925.

7. Cunningham, R. L.: Normal, Absent and Pathologic Tonsils in Young Women: A Comparison of Histories, Arch. Int. Med. **47**:513 (April) 1931.

8. Clarke, J. A., Jr., and Rogers, H. L.: A Statistical Study of Allergic (Vasomotor) Rhinitis, Arch. Otolaryng. **25**:124 (Feb.) 1937.

Ascher and Giese<sup>9</sup> showed that in a group of 2,186 allergic patients the average incidence of tonsillectomy was 38 per cent. Statistical studies by Cunningham<sup>7</sup> on 7,958 college women, between the ages of 15 and 19 years, revealed that the tonsils had been removed in 2,756, or 34.6 per cent.

Piness and Miller<sup>1</sup> further stated that it is a common belief that the signs and symptoms of allergy are due to infection. In a group of 273 children with bronchial asthma, they found that 119, or 43 per cent, had been advised that tonsillectomy would relieve the asthma. No proof was found to indicate that tonsillectomy relieved these patients. The fact that 751 children reported at the allergy clinic conducted by Piness and Miller after tonsillectomy had been performed is evidence that the procedure failed to give relief. It was further noted that in 116, or 17 per cent of 685 allergic children the first frank allergic symptoms developed after tonsillectomy, and many others complained that mild symptoms had been aggravated.

TABLE 3.—*Complaints and Symptoms in Cases of Nasal Allergy*

Nasal obstruction, discharge, sneezing, itching of nose, etc.....	10
Headache.....	2
Sore throat and sneezing.....	1
Frequent infections of upper respiratory tract.....	1
Nasal obstruction and discharge.....	9
Sore throat.....	2
Swollen cervical glands.....	1
Total.....	26

TABLE 4.—*Occurrence of Acute Infections Diseases in Twenty-Six Cases of Nasal Allergy*

Disease	No. of Cases
Measles.....	6
Scarlet fever.....	2
Pertussis.....	2
Parotitis.....	2
Chickenpox.....	1
Scarlet fever and pertussis.....	2
Measles and pertussis.....	2
Total.....	17

Our observations agree with those of Piness and Miller that tonsillectomy is often recommended for the relief of the symptoms of allergy because they have been mistaken for those of infection. In the absence of hay fever and asthma, nasal allergy and allergic bronchitis are frequently undiagnosed.

9. Waldbott, G. L.; Ascher, M. S., and Giese, F. W.: Results of Tonsillectomy in Allergic Patients, *J. Michigan M. Soc.* **35**:369, 1936.

Piness and Miller noted in the reexamination of 544 allergic children from whom the tonsils had been removed that 71, or 13 per cent, showed an excessive regrowth of lymphoid tissue in the tonsillar fossae.

According to a recent survey by Collins,<sup>10</sup> 1,235,000 tonsillectomies are performed each year in the United States. If one considers the incidence of allergy among patients having routine tonsillectomies as 13 per cent, about 160,000 allergic patients are subjected to this procedure in the United States per year.

Although tonsillectomy is indicated in certain patients who have nasal allergy, it is important to bear in mind that this procedure will not materially influence the allergic symptoms. The indications for tonsillectomy in children with nasal allergy should be the same as those in children without nasal allergy. In children with nasal allergy it is hardly possible to determine the incidence of infectious colds unless repeated clinical observations are made over a period of one to two years, during which time the cytologic character of the nasal and sinusal secretions is correlated with the history and physical findings. Our observations on allergic children show that the highest incidence of colds occurs during the ages of 6, 7 and 8 years. It has been our experience that the majority of allergic children do not have more than the normal number of colds and that sinusitis is not a common complication.

By means of roentgenographic studies of the nasopharynx of children with nasal allergy, Cohen<sup>11</sup> has shown that edema of the adenoids is not uncommon. Subsidence of this edema was noted as a result of satisfactory management of the allergy. Enlargement of the adenoids in these cases, therefore, is not always an indication for surgical intervention.

The relative value of tonsillectomy in allergic children has been presented also in a recent report by Waldbott and his associates.<sup>9</sup> In a group of 1,112 patients with hay fever and asthma studied by them, tonsillectomy was performed in 228 before the onset of allergic symptoms and in 205 after allergic manifestations had developed. Of the latter group, definite relief occurred in 1.9 per cent, temporary relief in 1.9 per cent and aggravations of allergic symptoms in 11.6 per cent. In a control group of 60 patients subjected to tonsillectomy after they had been under observation the results were about the same. When tonsillectomy was performed for conditions other than allergy, it was successful in 35.2 per cent of the allergic group and in 36.4 per cent of the preallergic group, as compared with 72 per cent of the normal

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10. Collins, S. D.: Frequency of Surgical Procedures Among Nine Thousand Families, Based on Nationwide Periodic Canvasses 1928-1931, *Pub. Health Rep* 53:587, 1938.

11. Cohen, M. B.: Personal communication to the authors.

controls in whom improvement was recorded. Of 226 patients subjected to tonsillectomy before the onset of allergic symptoms, allergic manifestations developed in 14.4 per cent within three months, in 29.3 per cent within six months and in 48.6 per cent within two years after the operation. This is comparable with 26 per cent showing frankly allergic symptoms within three months, 47 per cent within six months and 63 per cent within two years. Of the patients whose tonsils were removed for the relief of nasal colds and bronchitis, tonsillectomy was of more benefit in the earlier age groups. The operation was less successful when performed during the pollen season. Although the results of tonsillectomies were disappointing, Waldbott and his co-workers expressed the belief that tonsillectomy should be performed in patients having frequent infections. In others with allergic catarrh of the upper part of the respiratory tract, which may or may not involve the tonsils, they concluded that tonsillar tissue is a definite asset to the system and should be preserved.

#### SUMMARY

1. In the management of frequent colds, sinusitis, bronchitis and recurrent pneumonia the possibility of allergy as an etiologic factor must always be considered.

2. Of 200 children considered as a routine for removal of the tonsils and adenoids because of these complaints, a definite diagnosis of nasal allergy was established in 26, or 13 per cent. It is significant that 6 of these patients had hay fever.

3. These cases of respiratory allergy may be overlooked unless an adequate history, physical examination and cytologic studies of the nasal secretion are carried out in each instance.

4. Removal of the tonsils and adenoids in allergic children should not be performed during hay fever seasons, and the indications for operation should be the same as in nonallergic children.

5. The tonsils and adenoids should not be removed with the idea of alleviating allergic symptoms.

# ALTERATIONS IN NASAL FUNCTION DUE TO ANATOMIC VARIATIONS OF THE NARES

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The importance of the inspiratory and expiratory air currents in nasal function has been firmly established for many years. Goodale<sup>1</sup> and Lambert Lack<sup>2</sup> proved by their experiments that a stream of inspired air does not pursue a straight course from nostril to choana but passes in a wide curve which begins at the nostril, extends through the olfactory fissure and ends in the upper part of the choana. The current of air does not touch the inferior turbinate except for small eddies which curl (1) against the face of the sphenoid, (2) over the inferior turbinates and (3) into the sphenoid sinus.

At a much later date the experiments by Proetz,<sup>3</sup> using litmus paper and smoke trails, corroborated these observations. He also added a distinct inspiratory eddy of air in the nasofrontal angle.

Proetz's experiment with smoke brought out an important factor for clinical consideration. It was apparent from watching the smoke trails in the nose that the direction of the air current is determined by two factors. The first is the shape and position of the inlet (nostril) and the second the angle at which the inspired air impinges against the slope of the bridge of the nose; the choana, being larger than the nostril, does not modify the flow or direction of the current as it enters.

Further investigations by Proetz revealed other significant data. Thinness, shrinking or amputation of the middle turbinates does not materially alter either the inspiratory or the expiratory currents. But when obstacles are introduced either on the septal or the lateral wall, pronounced changes are observed, and the entire current of air is broken into numerous eddies.

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Presented as a candidate's thesis to the American Laryngological, Rhinological and Otological Society, Inc.

1. Goodale, cited by Thomson, St. Clair: *Diseases of the Nose and Throat*, ed. 3, London, Cassell & Company, Ltd., 1926, p. 6.

2. Lack, L., cited by Thomson, St. Clair: *Diseases of the Nose and Throat*, ed. 3, London, Cassell & Company, Ltd., 1926, p. 7.

3. Proetz, A. W.: *Some Intimate Studies of Nasal Function: Their Bearing on Diagnosis and Treatment*, *Ann. Otol., Rhin. & Laryng.* 41:125 (March) 1932.



These experiments proved that an inspiratory stream of air can be deflected and broken by the shape and position of the nasal aperture and also by any mechanical obstacle or alteration in the lateral and middle walls of the nose.

The various structures which, if abnormal, can deflect these inspiratory air currents may be grouped under the general term "nares." Specifically they are the columella, the anterior portion of the nasal septum, the alar cartilage with lateral and medial crura, the upper lateral cartilages and the small constrictor-dilator muscles of the nose.

The following groups of cases will show that each of these structures plays an important role in the deflection of inspired air and the subsequent changes in nasal physiology.

#### I. ELONGATED, BEAKED NOSE

A beaked nose shows a marked forward prolongation of the anterior septum and downward projection of the angle of the alar cartilages (fig. 1, 1 to 4).

The patients present alterations in the physiologic condition of the nose. Their usual complaints are nasal stuffiness, frequent "colds," occasional headaches and dryness of the nose. This pathologic syndrome is due to the mechanical alteration of the air currents caused by the distorted shape of the tip of the nose. The downward projection of the "beaked" tip disrupts the normal circuitous route of the inspiratory current of air, producing eddies and whorls in the nasal passages. Heretofore, the usual intranasal treatments and surgical procedures have afforded little relief to the sufferers.

A simple test to ascertain whether these patients will obtain relief is to stand on the right side of the patient and raise the tip of the nose with the middle finger of the right hand. If the patient experiences easier breathing, one can safely say that the operation will give exactly the same amount of improvement. If there is no improvement in nasal breathing when the tip of the nose is raised, operation is not indicated.

The corrective operation for this condition is simple. It is important to ascertain how high the tip of the nose must be raised in order to obtain the desired result. This knowledge is had by raising the tip of the patient's nose until he attains the maximum relief. The height to which the tip must be raised indicates how much cartilage must be removed.

An intercartilaginous incision is made between the upper lateral and the alar cartilage, intranasally, on one side. A small pair of scissors is then inserted into the opening, and the skin is separated from its adjacent perichondrium and periosteum up to the glabella. The same procedure is followed on the opposite side. A long straight Joseph knife is then inserted through one incision and passed through the

second incision on the other side, making a common communication, which is carried forward to the columella, the upper border of the septum thus being separated from the skin. Then the separation is carried downward in the fibrous communication, the columella being separated from the anterior border of the nasal septum down to the

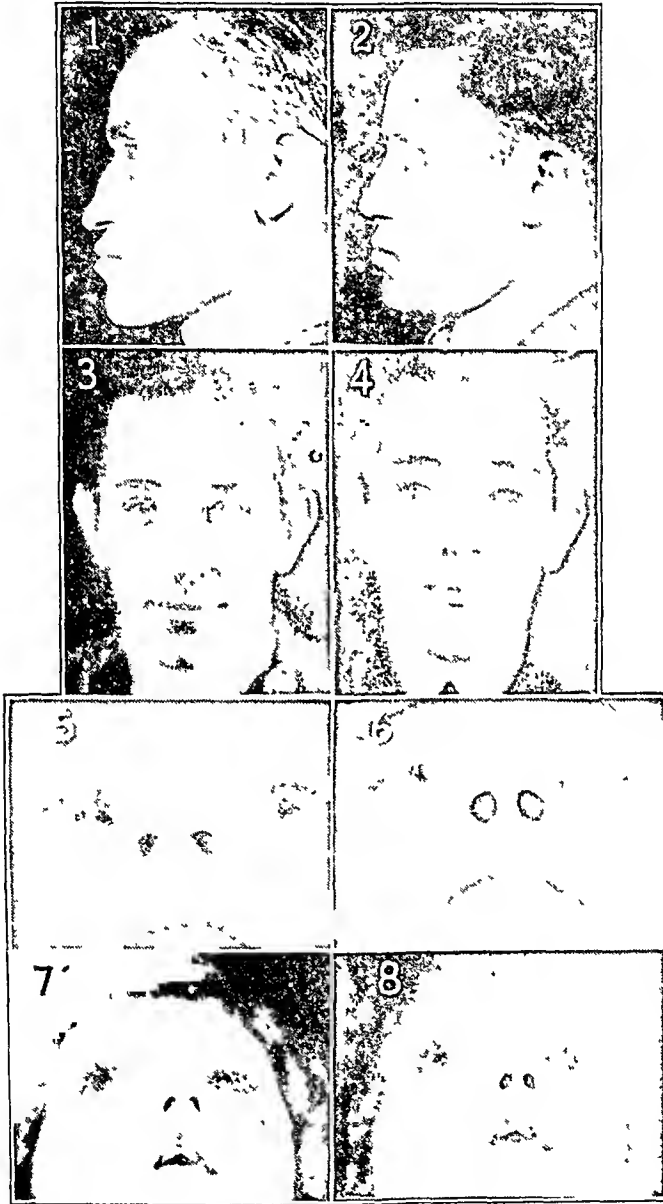


Fig. 1.—Beaked nose, with correction (1 to 4). Wide separation of the medial crura of the alar cartilages, with correction (5 and 6). Wide columella due only to redundant tissue, with correction (7 and 8).

philtrum. A triangle with its base upward and its apex caudalward is removed from the septum with its perichondrium and mucous membrane. The columella and the septum are then sutured together with two orthopedic stitches.

## II. HYPERTROPHIED COLUMELLA

Any structural change in the anatomic arrangement of the columella can deflect the inspiratory air current and cause a disturbance in nasal functions. Many interesting abnormalities in this classification may be responsible for such a change.

A. *Wide Separation of the Medial Crura of the Alar Cartilages.*—Normally the medial crus of the alar cartilage comes in close contact with its fellow on the other side, forming a narrow, straight supporting columella. When the medial crura are widely separated, with the interposition of adipose and fibrous tissues (fig. 1, 5 and 6), the columella becomes broad and short and acts as a buffer to the inspiratory stream of air.

The corrective measure which I have used successfully is as follows: A straight longitudinal incision is made through the center of the columella. The edges are widely separated with fine nasal hooks, an exposure of the anatomic defect being permitted. All the interposing tissue between the medial crura is dissected out thoroughly. The medial crura, now free, are brought together with two heavy black silk mattress sutures. One suture is placed high and the other low on the columella. The longitudinal cutaneous incision on the columella is brought together with fine interrupted dermal sutures. The heavy black silk mattress sutures are allowed to remain for seven days.

B. *Wide Columella Due Only to Redundant Tissue.*—This abnormality (fig. 1, 7 and 8) is not uncommon in children. The columella is filled with fatty and connective tissue which causes its lower part to flare out, the inlet being thereby narrowed. In such cases, the inspiratory current of air is deflected, nasal function being disturbed. The children present adenoid facies. It will be worth observing these cases in later years, after proper correction of the columella, to see if there are any changes in the facial expressions and characteristics. The oldest operation in this category was done only a little over a year ago, and it is too early to make any definite statement. The patients that have been operated on showed marked improvement in nasal hygiene, mental alertness and general physical condition.

The corrective operation for this condition follows: A longitudinal incision is made, separating the columella from the anterior border of the septum. Both lips of the columella are retracted outward with fine nasal hooks. All redundant tissue in the columella is resected. Histologic examination will show adipose and fibrous tissues, with some muscle. The septal mucosa is gently sutured to the epidermal layer of the columella on both sides. Two or three sutures may be required to bring these structures into alinement. Two heavy black mattress sutures are used to bring together the lips of the columella. This mattress suture

is placed only through one side of the columella to the other. When these sutures are brought together, the columella becomes rather narrow, and the nasal aperture rounds out to its normal shape.

*C. Redundant Tissue of Entire Nares.*—This condition is usually due to cutaneous disorders of the face, especially acne (fig. 2, 1 and

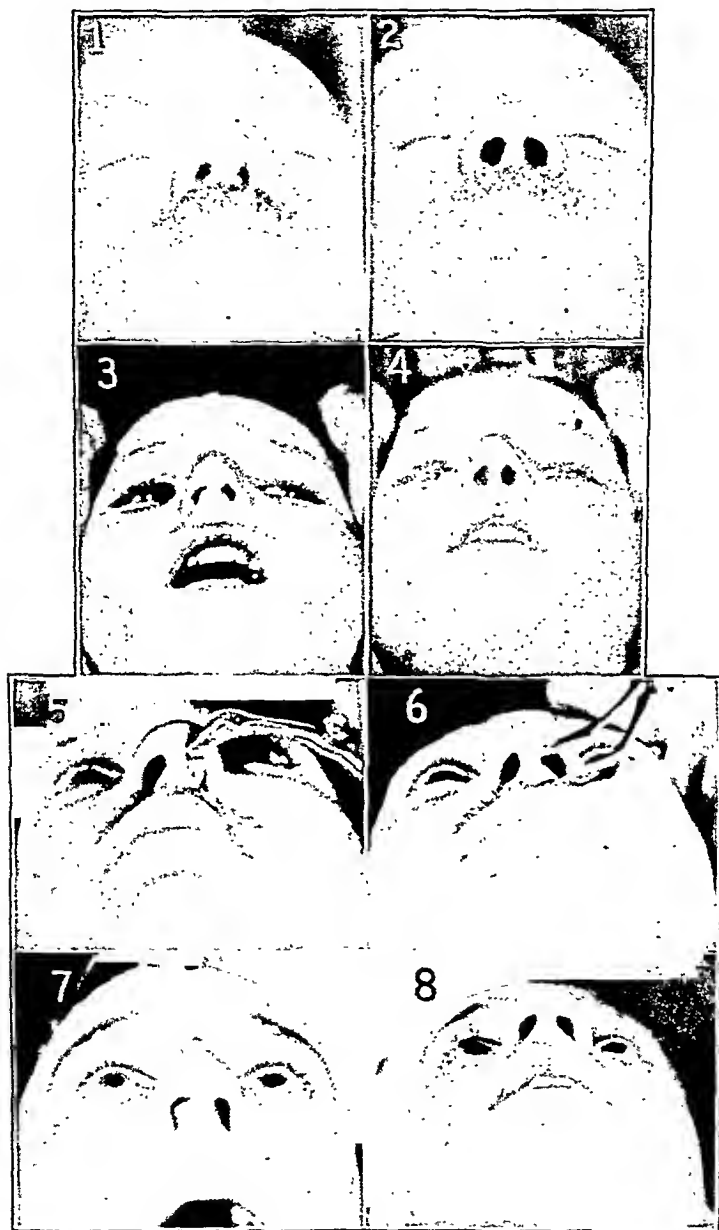


Fig. 2.—Redundant tissue of entire nares, with correction (1 and 2). Anterior septal dislocation with hypertrophy of the columella, with correction (3 and 4). Dislocation of a fractured septum to the left with concavity of the septum on the right, with correction (5 and 6). Dislocation of anterior part of septum, opposite side not requiring adjustment, with correction (7 and 8).

2). The redundancy may be so marked that the nasal aperture may become completely occluded.

The corrective surgical procedure in such cases is the operation on the columella just described plus a parallel incision in each prominent

rim of the nostril. Care must be taken that when the redundant tissue from the side of the nose is being dissected out the small nasal muscles and the lateral crus of the alar cartilage are not disturbed. The importance of these small muscles will be discussed later. Dermal sutures are used to close the wound after enough tissue has been removed.

*D. Anterior Septal Dislocation with Hypertrophy of the Columella.*—Patients with this type of abnormality usually present an anterior dislocation of the septum due to fracture. The dislocated segment of the septum is pushed forward into the columella, which is broadened while the nasal entrance is narrowed (fig. 2, 3 and 4). The right side of the columella in fig. 2, 3, shows the dislocated segment of the septum, which causes the columella to flare out. The hypertrophy on the left side is due to redundant tissue in the columella.

A longitudinal incision separates the anterior septum from the columella. The lips of the columella are retracted outward with fine nasal hooks. The redundant tissue on the left side is dissected out. The dislocated segment of the septum is dissected out in toto from the columella on the right side. If the structural support of the nose is not disturbed, the dissected segment is not reinserted, and the incisions are closed in the usual manner.

If too much anterior septum has been removed, then the segment is reinserted between the lips of the columella. The manner in which this graft is held together will be described further on.

### III. DISLOCATION OF ANTERIOR NASAL SEPTUM DUE TO FRACTURE

Dislocation of the anterior part of the nasal septum due to fracture is seen frequently. The disturbance in the nasal function created by the deformity is well known to the rhinologist. Many classic operations have been described as a remedy. Figure 2, 5, shows marked dislocation of a fractured septum toward the left, with concavity of the septum on the right side. A longitudinal incision is made, separating the columella from the anterior part of the septum. The septal mucosa and perichondrium are separated from the anterior part of the quadrilateral cartilage on both sides, to a point behind the dislocation. This entire portion is dissected out. As much as possible of the projecting portion of the dislocated part is shaved off with a sharp scalpel. If the cartilage is still bent, the tension can be released with vertical and horizontal incisions through it. It is then reinserted between the open lips of the columella. The septal mucosa is sutured with dermal sutures to the epidermal layers of the columella. It is necessary to suture the graft in place to prevent sloughing or buckling caused by its falling either forward or backward.

Two heavy black silk mattress sutures are placed through the septal portion of the inserted cartilage, carried through to the opposite side

and then through the columella on the same level and united. These supporting sutures remain from seven to ten days, when the "graft" will become well embedded in a mesh of fibrous tissue. The purpose of this procedure is to straighten out the weak concave wall on the opposite side of the dislocation and to give support to the nose. Figure 2, 6, shows the end result. Figure 2, 7, shows a marked dislocation of the anterior part of the septum, but the opposite side does not require any adjustment. The classic procedure of removing the dislocated segment in toto without interfering with the cartilage and its coverings on the opposite side is well known and requires only a comment. It is best to remove a small portion of the mucous membrane when bringing together the two open edges of the original incision. If this is not done, the excess areas of mucous membrane will buckle on each other and act as a buffer to the inspiratory stream of air.

#### IV. HYPERTROPHIC UPPER LATERAL CARTILAGES

Hypertrophy of the upper lateral cartilages is not uncommon. It may be congenital or acquired through trauma. Its position is usually downward and mediad. This prevents the inspiratory air from taking its normal circuitous route and gives rise to nasal symptoms.

If the lower lateral cartilage is atrophied, the downward pressure of the hypertrophic upper lateral cartilage usually causes an inward pinch on the lateral part of the lower third of the nose. In such cases, the surgical procedure is to free the lateral extremity of the upper lateral cartilage from its fibrous connection to the apertura piriformis, leaving its medial attachment to the upper border of the septum nasi intact. The freed end is then brought downward, filling in the weak area of the nose between the skin and the nasal mucosa, held in place with sutures endonasally, or through the nose, and sutured on the outside, with an interposed layer of cotton or gauze.

This technic accomplishes two things: First, it strengthens the weak lateral wall of the nose, and, second, it eliminates the endonasal obstruction and permits the inspiratory current of air to assume its normal route.

In cases in which the lower lateral cartilage is not atrophied, a sub-mucous resection of the hypertrophied tissue is sufficient to allow the inspiratory current of air to have ample space.

#### V. MUSCULAR IMBALANCE OR MUSCULAR ATROPHY OF THE NARES

The muscles of the nares work antagonistically. There are two sets of nasal muscular fibers, the constrictors and the dilators. These muscles are considered rudimentary. However, I do not subscribe to that theory. These muscles have a definite function, and when their

contractile powers are lost there is a marked alteration in nasal function. In a forthcoming paper, the origin, insertion and definite function of each muscle of the nares will be described, as well as the atrophy of the muscles of collapsed nares.

Such cases are observed frequently. On inspiration there is marked collapse of the entire lateral wall of the nose, in some instances giving a slitlike appearance to the nostrils. The majority of patients, however, do not have so marked a collapse. Because of the weak and atrophied nasal muscles, the area corresponding to the upper lateral cartilage is constricted on inspiration, although the rim of the naris flares out. There is a sense of obstruction, and the patient inspires more forcibly in an attempt to bring more air into the nares. This effort causes marked constriction of the weakened area, which at times impinges on the nasal septum, producing more obstruction to the inspiratory current of air.

Fig. 3, 1 to 4, illustrates the cases of complete muscular imbalance. On inspiration there is a collapse of the entire nose, only a small distorted stream of inspiratory air being permitted to enter. The alteration in nasal function in such conditions is marked.

Figure 3, 1 and 2, presents a patient with an unusual symptom, anosmia. She perceived only the strongest odors. Directly after operation she was able to detect the odor of a rose. There is a physiologic explanation for such a change. For one to become conscious of odors there must be some stimulation of the protoplasmic filaments in the olfactory vesicle of van der Stricht. The olfactory hairs in this region act as receptors and respond to the stimulation carried to them by the inspiratory current of air. The reason that many patients with this condition have anosmia with nasal stuffiness and frontal headaches is that the inspiratory current of air becomes wholly or in part deflected from its normal path.

Figure 3, 5 and 7, shows patients in whom there is not a complete collapse of the nares on inspiration but a constriction of the upper lateral portion (corresponding to the upper lateral cartilage), caused by imbalance of muscular contraction or atrophy of the upper lateral cartilages. This constriction in many cases is so marked as to cause impingement on the septum, but the lower part of the nostril (inlet) remains open. Photographically, it is not possible to show the constriction of the upper lateral part of the nares toward the septum on inspiration. Figure 3, 6 and 8, shows the correction of this condition, with the subsequent increase in the length and diameter of the nares.

In this group, a simple test will indicate whether surgical intervention will be beneficial. A small thin wooden applicator is inserted in each nostril. The nares are pushed outward, upward and laterally as far as

possible. If the patient experiences a marked increase in the volume of air on inspiration, one can safely predict that the operation will afford the same amount of relief.

The surgical correction of this condition is simply to transpose the nares more laterally in a fixed position, so that they will not collapse on

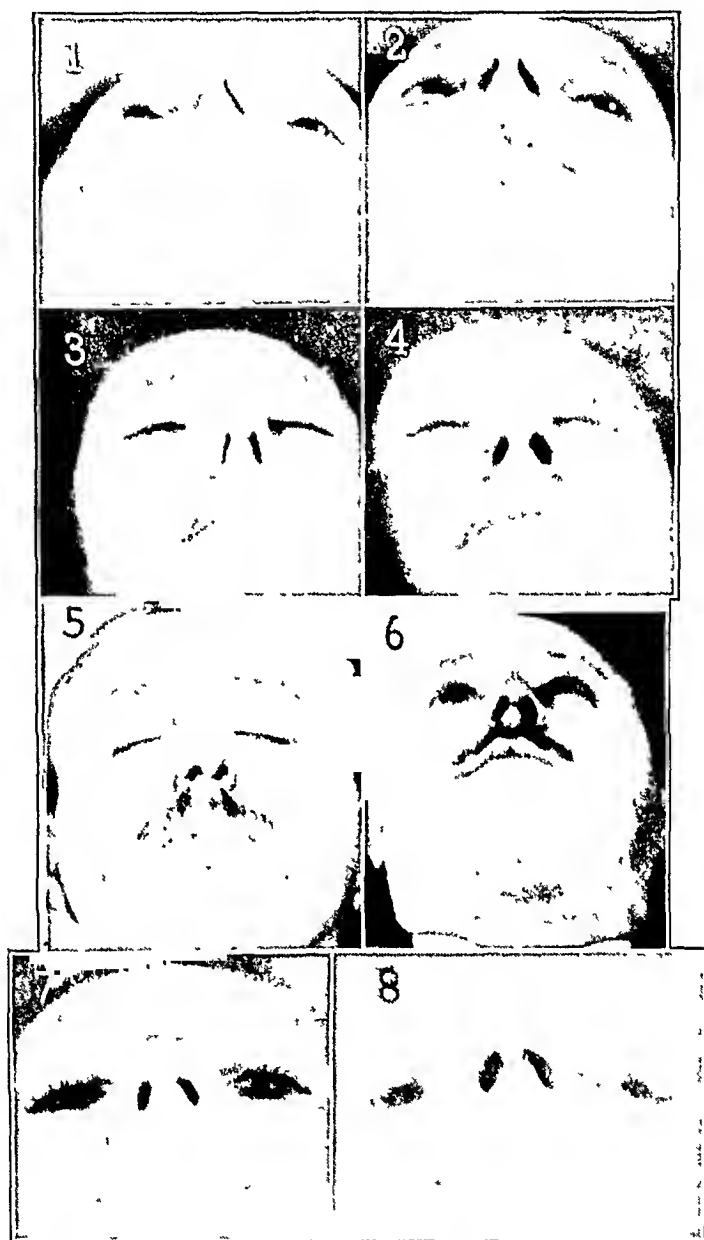


Fig. 3.—Complete muscular imbalance, with correction (1 to 4). Constriction of the upper lateral portion of the nares, with correction (5 to 8).

inspiration. This operation has been termed "lateral transfixation of the nares" (fig. 4, 1 to 12).

It is performed with the patient under local anesthesia. Figure 4, 1, shows a semilunar incision in the nasolabial fold. Figure 4, 2, shows an Allis clamp grasping the upper edge of the cutaneous incision, with a



scalpel dissecting the deeper layers. Figure 4, 3, shows all the layers, viz., cutaneous, subcutaneous and muscular layers, totally resected. The thin layer exposed and left intact is the mucous membrane of the nose. Figure 4, 4, shows a long, straight needle with 00 forty day chromic

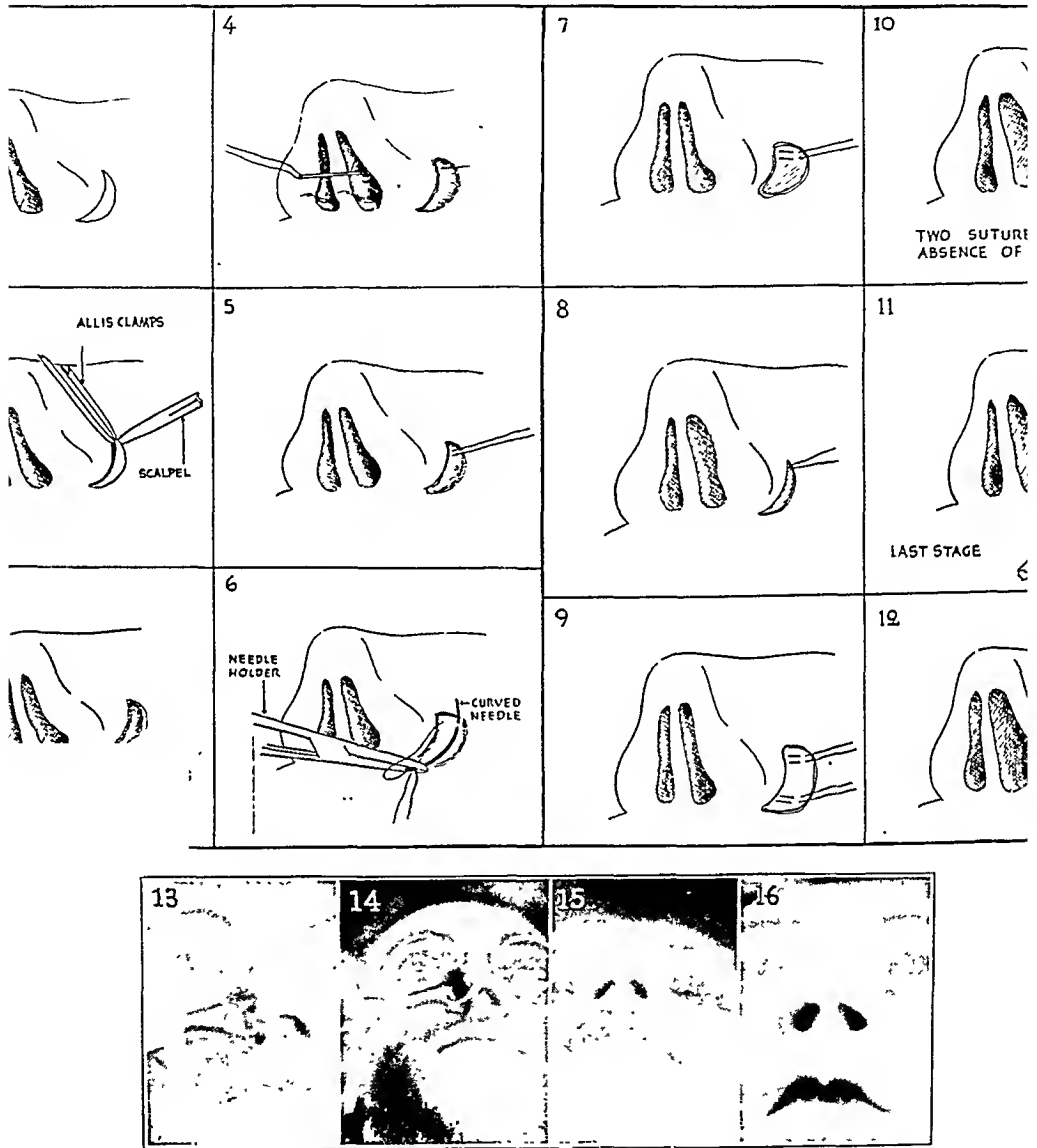


Fig. 4.—Lateral transfixation of the nares (1 to 12). Anterior atresia of the nares, with correction (13 and 14). Acquired collapse of the tip of the nose, shortening and narrowing the nostrils, with correction (15 and 16).

catgut being passed through the nasal mucosa at a level corresponding to the highest point of the incision and carried outward. Figure 4, 5, is the same procedure with the same suture directly below it. Figure 4, 6, shows the upper suture on a curved needle being fixed laterally on

the same plane. Figure 4, 7, shows these two sutures completed but untied, with the entire nares collapsed. Figure 4, 8, shows these two sutures tied and fixed laterally, with the upper part of the nares wide open and enlarged. Figure 4, 9 and 10, shows the same procedures but at the lower end of the incision and also the relation of the nares to the sutures when tied and untied. Figure 4, 10, shows that when the sutures are tied the collapsed nares become enlarged in height and width and become permanently transfixed laterally. Figure 4, 11, shows the dermal sutures closing the cutaneous wound, and 12, the final result.

No packing is inserted in the nose. No external dressing whatever is employed. The nose is kept clean with sterile glycerin. There is absolutely no change in the external contour of the nose, and the scar is not visible, as it is well covered in the new nasolabial fold. The dermal sutures may be removed on the third day.

#### VI. SMALL NOSTRILS

Small nostrils present a distinct obstruction to the inspiratory current of air and are easily diagnosed. The advent of rhinoplastic surgery has produced more anterior nasal atresia than any other etiologic factor. This atresia is formed when an inexperienced operator attempts to narrow the tip of the nose and unwittingly removes too much nasal mucosa. Naturally there are many other etiologic factors. Figure 4, 13 and 14, shows anterior atresia of the nares, with correction. The weblike atresia was removed in toto, and a Thiersch graft was inserted.

There is another group of cases which interests the rhinologist. The tip of the nose, as it collapses, shortens and narrows the nostrils. This condition may be congenital or acquired. When acquired (fig. 4, 15) it is sometimes due to a high and anterior submucous resection.

The method of correction varies with the individual case. If the columella is weak, an ivory or cartilaginous support placed within its lips from the tip of the nose to the philtrum may be sufficient. If the nares are weak or collapsed, this support is combined with lateral transfixation of the nares, as illustrated in figure 4, 16.

#### SUMMARY

Physiologists in the past have shown that the inspiratory and expiratory streams of air take a definite circuitous path in the nasal chamber.

These observations were further established by the works of Proetz, using litmus paper and smoke trails.

Proetz showed in his experiments that the direction of the air currents is determined by the shape and position of the inlet (nostril). He further showed that when obstacles of any description are introduced either on the septal or the lateral wall, they produce the most pronounced changes, and the current is broken into eddies and whorls.

Observations in a variety of cases have been described which corroborate these experiments in every detail.

Although not enough time has elapsed to warrant dogmatic statements, the following observations have been made: After surgical correction the nasal breathing improved from 50 to 100 per cent. The number and intensity of colds will be reduced. In selected cases, frontal headaches were relieved and anosmia cured. Postnasal drip diminished 30 per cent in some cases. In the majority of the patients mental alertness and physical condition were markedly improved.

I intend to show in a subsequent paper that the so-called rudimentary muscles of the nose have a definite physiologic role and that failure of these muscles to function produces a marked disturbance in nasal hygiene.

A new operation, "lateral transfixation of nares," is presented.

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# A METHOD FOR RECONSTRUCTION OF POSTAURICULAR DEFECTS

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AND

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OMAHA

There falls into the hands of every reconstructive surgeon a certain group of cases in which postauricular defects have been operated on repeatedly with little or no success. These defects may be the result of uncontrolled infection, of incomplete operation on the mastoid, such as simple antrotomy and poorly executed radical mastoidectomy, or, as in one case which we observed, of the spontaneous perforation of an untreated diseased mastoid.

The resulting unsightly defect is manifested as a depression in the region of the former mastoid prominence, covered wholly or in part by a thin, reddened and contracted scar, which is usually painful in varying degrees and is further made an annoyance by a discharge.

With the demands on the modern plastic surgeon becoming more and more exacting, the need was felt for a review of this problem. The anatomic and surgical questions presented were reconsidered in order to establish some operative principles to insure, as far as possible, satisfactory functional and cosmetic results.

## REVIEW OF THE LITERATURE

Zoufal<sup>1</sup> in his description of the first radical mastoidectomies considered a permanent postauricular opening essential. This was disfiguring. Epithelization was allowed to take place from behind the ear rather than encouraged by splitting the membranous external auditory meatus after immediate closure of the wound, as is now commonly done. The endaural approach, revived by Lempert,<sup>2</sup> gives excellent results from the cosmetic point of view.

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1. Cited by Gerber, P. H.: *Handatlas der Operationen am Schläfenbein*, Wiesbaden, J. F. Bergmann, 1904.

2. Lempert, J.: Endaural, Antauricular Surgical Approach to Temporal Bone: Principles Involved in This New Approach; Summary Report of One Thousand, Seven Hundred and Eighty Cases, *Arch. Otolaryng.* 27:555 (May) 1938.

The successful correction of postauricular defects depends on the use of various types of tissue grafts and flaps. Simple undermining of the skin adjacent to the defect to obtain relaxation, with accurate opposition of its edges, is the most common method of secondary closure. The skin is frequently under tension after this type of operation, but the defect is usually small, and successful closure is frequently obtained.

The simple epidermal flap described by Mostig-Moorhof<sup>1</sup> is cut from below the defect, retaining an attachment at its inferior periphery. The flap is liberated and rotated into the cavity with the epithelium toward it. Slight modifications of this technic, with the flaps placed posterior or superior to the defect, with or without relaxing incisions, were described by Trautmann,<sup>3</sup> Beck,<sup>4</sup> Goldstein,<sup>4</sup> Kerrison,<sup>4</sup> Watson,<sup>5</sup> Lautenschlager<sup>4</sup> and Heine.<sup>6</sup>

The periosteal and subcutaneous flap was advised by Popper,<sup>7</sup> and in describing his technic he suggested the use of a large horseshoe-shaped periosteal flap cut from behind the mastoid and attached to the postauricular fold, which is reflected into the defect. McNichols<sup>8</sup> and Ashley<sup>9</sup> also suggested periosteal and subcutaneous flaps, variously modified, for the closure of such defects.

Copps and McCormick<sup>10</sup> use subcutaneous tissue posterior to the defect for filling the concavity of the mastoid, but they do not incise further than the initial incision for freeing the skin. Instead, they leave an area over which the skin is placed under tension, without subcutaneous tissue in its posterior portion but with skin and the transplanted subcutaneous tissue over the defect.

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3. Trautmann, cited by Phillips, W. C.: *Diseases of the Ear, Nose and Throat, Medical and Surgical*, ed. 4, Philadelphia, F. A. Davis Company, 1917, p. 303.

4. Cited by Kirschner, M.: *Operative Surgery*, Philadelphia, J. B. Lippincott Company, 1937, p. 39.

5. Watson, D.: *Correction of Mastoid Defects*, Proc. Roy. Soc. Med. **23**: 397, 1930.

6. Heine, B., cited by Kerrison, P. D.: *Diseases of the Ear*, ed. 2, Philadelphia, J. B. Lippincott Company, 1921, p. 459.

7. Popper, O.: *The Use of Periosteal Flap Grafts in Mastoid Operations*, J. Laryng. & Otol. **47**:126, 1932.

8. McNichols, W. A.: *Prevention of Postauricular Fistula by Periosteal and Subcutaneous Tissue Flaps*, Ann. Otol., Rhin. & Laryng. **45**:475, 1936.

9. Ashley, R. E.: *A New Method for Closing a Postauricular Fistula*, Ann. Otol., Rhin. & Laryng. **46**:477, 1937.

10. Copps, L. A., and McCormick, G. L.: *The Closure of Persistent Post-operative Mastoid Fistula with a Subcutaneous Pedunculated Flap*, Arch. Otolaryng. **27**:472 (April) 1938.

A pedicle scalp flap is employed by Straatsma<sup>11</sup> for filling postauricular defects. On the raw surface of the flap is placed a Thiersch graft. After the flap with its accompanying graft has taken in its new bed, its unusual portion is returned to its original site, and a split skin graft from the thigh or abdomen is used as necessary for covering the remaining defect.

Ersner and Myers<sup>12</sup> utilize a "racket-shaped" pedicle flap from the neck, which is transplanted into the defect, with its pedicle severed after a take is assured.

Straatsma and Peer<sup>13</sup> reported the successful use of free grafts of fat from the thigh and abdomen for the correction of postauricular defects. Eagleton<sup>14</sup> employed bone and bone chips for the same purpose.

A purse string suture is used by Passow<sup>4</sup> for closing the deep layer of a double layer flap made over the same type of irregularity.

Kisch<sup>15</sup> described a flap from the temporal muscle, in which a "tongue" of muscle is transferred directly into the defect, retaining an attachment in its anterior portion. Almour<sup>16</sup> described a similar operation, in which the muscle is freed and transposed directly into the defect, retaining an attachment "by a narrow pedicle located in the upper anterior quadrant of the mastoid cavity." The flap is rotated on its pedicle to have the periosteum next to the bone, while the operation of Kisch does not call for such a procedure.

#### FACTORS IN THE CHOICE OF OPERATION

The incidence of large postauricular deformities following operation on the mastoid is increased by such concomitant systemic conditions as tuberculosis, syphilis, diabetes mellitus, scarlet fever and hematic dyscrasia. Extensive pneumatization of the mastoids, with large cavities resulting from the removal of the diseased bone, usually causes a gross deformity. Poor surgical technic at the time of operation, with failure to appose the edges of the skin properly, or undue tension of the parts tends to minimize the possibilities of a satisfactory result.

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11. Straatsma, C. R.: Repair of Postauricular Fistula Following Radical Mastoidectomy, *Arch. Otolaryng.* **19**:616 (May) 1934.

12. Ersner, M. S., and Myers, D.: Variation of Pedicle Flap for Epitheliation of Radical Mastoidectomy Cavity, *Arch. Otolaryng.* **23**:469 (April) 1936.

13. Straatsma, C. R., and Peer, L. A.: Repair of Postauricular Fistula by Means of Free Fat Graft, *Arch. Otolaryng.* **15**:620 (April) 1932.

14. Eagleton, W. P.: Reconstruction of Mastoid Wound Cavity by Use of Bone Grafts and Chips, *Laryngoscope* **29**:272, 1919.

15. Kisch, H.: Temporal Muscle Flap, *J. Laryng. & Otol.* **43**:856, 1928.

16. Almour, R.: Method for Repair of Persistent Postauricular Openings, *Laryngoscope* **40**:799, 1930.

Secondary infections resulting in erysipelas or an erysipeloid reaction, with which closure is delayed or is not attempted, terminate in the defect being filled with granulations and epithelization taking place in an unsatisfactory manner. It has been found, in reviewing the cases on which this paper is based, that a large portion of extensive postauricular defects follow such complications.

As in all operations involving the skin, after-care is as important as the operation itself. Poorly placed drains and packing, with resulting undue pressure on the epidermis is followed by ischemia and death of the superficial protective covering. The injudicious use of caustics also may contribute to poor recovery.

Allowing the wound created to close superficially before the underlying tissues have filled in the defect is usually followed by unsatisfactory results. As elsewhere in the body, due respect for the skin is demanded if a favorable end result is to be obtained.

With a postauricular deformity resulting from one or more of these factors, it is evident that the first step toward recovery is to eliminate all possible infection. This may entail a revision of the operation on the mastoid.

With a deformity of such a size that clinical judgment dictates the use of some form of plastic procedure, the type of operation must be weighed in the light of its feasibility in the case at hand.

Small defects can frequently be closed by simply undermining the edges of the skin for relaxation, freshening and approximating them.

A simple skin graft or epidermal flap might be indicated if the cavity presents the possibility of an adequate blood supply on a healthy granulating base. This type of repair merely covers the denuded bone and does not restore contour.

A free graft of fat or muscle may be considered. As a prerequisite to this operation a good blood supply plus adequate skin to cover the restored contour without undue tension is mandatory. Grafts of this type have the unfortunate tendency to diminish in size all too frequently, and what appears a good restoration of contour after the operation may literally melt away entirely in a short time.

Bone grafts and bone chips need not be considered in this discussion, as they are doomed to be lost unless they have the most favorable of fields.

A pedicle flap of skin or scalp may be considered. Such flaps carry their own blood supply, but the scar created by the operation is often as unsightly as the original deformity.

The periosteal and subcutaneous flap has definite indications. Nutrition is supplied from the donor site and the scarring is minimal. However, this type of operation is limited to the smaller deformities because

of the nature of the flap itself. The structure of the region from which it is taken precludes the use of too much tissue, because necrosis and ulceration intervene if the blood supply is inadequate.

For large defects, contour must be restored by an operation that itself does not have too great a defect, and the operation chosen must offer a reasonable expectation of success. To do this the following requirements must be met. There must be enough skin to cover the defect completely. The area in some cases is several square centimeters. The base on which the skin is to rest must carry its own blood supply and be such that postoperative absorption does not destroy the contour achieved. If the contour is restored with a tissue having an adequate blood supply and enough available skin to make an apposition of the various layers of tissue, then a favorable termination may be contemplated. To fulfil these conditions a muscle flap is the only material available.

#### ANATOMY

With these requirements, the anatomy of the temporal muscle was reconsidered when it was found that the middle temporal artery has subdivisions that might be utilized in the construction of a muscle flap.

The middle temporal artery is a branch of the superficial temporal artery arising just above the zygoma, and after perforating the temporal aponeurosis and muscle it ascends through the substance of the temporal muscle itself.<sup>17</sup> In anatomic literature the information as to the exact blood supply of the temporal muscle is meager, so that a study of the problem was found necessary. Human material consisting of both injected and uninjected specimens was examined, and it was found that the middle temporal artery usually branches into two divisions, anterior and posterior. The posterior division supplies the most posterior and inferior portion of the temporal muscle as its fibers pass directly posteriorly and horizontally.

In the series of specimens which we examined, the posterior division of the middle temporal artery was found to be fairly large, lying somewhere within 1.5 cm. of the inferior-posterior portion of the muscle. In 2 cases the artery was found to subdivide still further just as it was given off the middle temporal artery, with the result that two small arteries were present in the area rather than one relatively large branch. The posterior branch of the middle temporal artery has its origin anterior to the superficial temporal artery and then turns medially and posteriorly, to supply the muscle to be utilized in the construction of the flap. The muscle may be used as far anterior as the region where the temporal

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17. Piersol, G. A.: *Human Anatomy*, ed. 9, Philadelphia, J. B. Lippincott Company, 1930.



artery crosses its fibers, in the knowledge that it still has a good blood supply up to this point.

To satisfy the requirements further, a flap has to be constructed in such a manner that the lumen of the posterior branch of the middle temporal artery will not be occluded by torsion and at the same time have a broad base to insure the presence of this artery in it.

#### DESCRIPTION OF THE OPERATION

The following operation was devised in an attempt to fulfil the requirements laid down.

The incision starts at a point between the superior temporal line and the sagittal suture, about 2 cm. anterior to the bicauricular line (fig., *A*) and is carried down to the temporal fascia but does not involve it. It is straight, crossing the bicauricular line several centimeters above the ear, skirting the postauricular defect anteriorly and posteriorly and extending over the region of the mastoid.

The epithelial remnants within the anterior and posterior incisions over the defect are completely removed. An attempt is not made to remove granulation tissue. The defect is then packed temporarily, as it is ready to receive the muscle flap.

The skin is undermined anteriorly and posteriorly from the edges of the incision, with the line of cleavage on the temporal fascia. The undermining is carried cephalad beyond the superior temporal line, posteriorly to the occipital region, so that the most posterior portion of the temporal muscle is well exposed. Inferiorly and anteriorly the skin is freed as far as the zygomatic arch. It is liberated 3 to 5 cm. below the tip of the mastoid. This procedure may seem a bit radical, but it is essential if there is to be enough skin to allow proper closure of the large defects for which the operation is intended. Considerable bleeding will be encountered under the flap raised in this manner, but this should cause no concern, as it can be adequately controlled by placing warm moist packs well underneath the flaps and applying manual pressure over them.

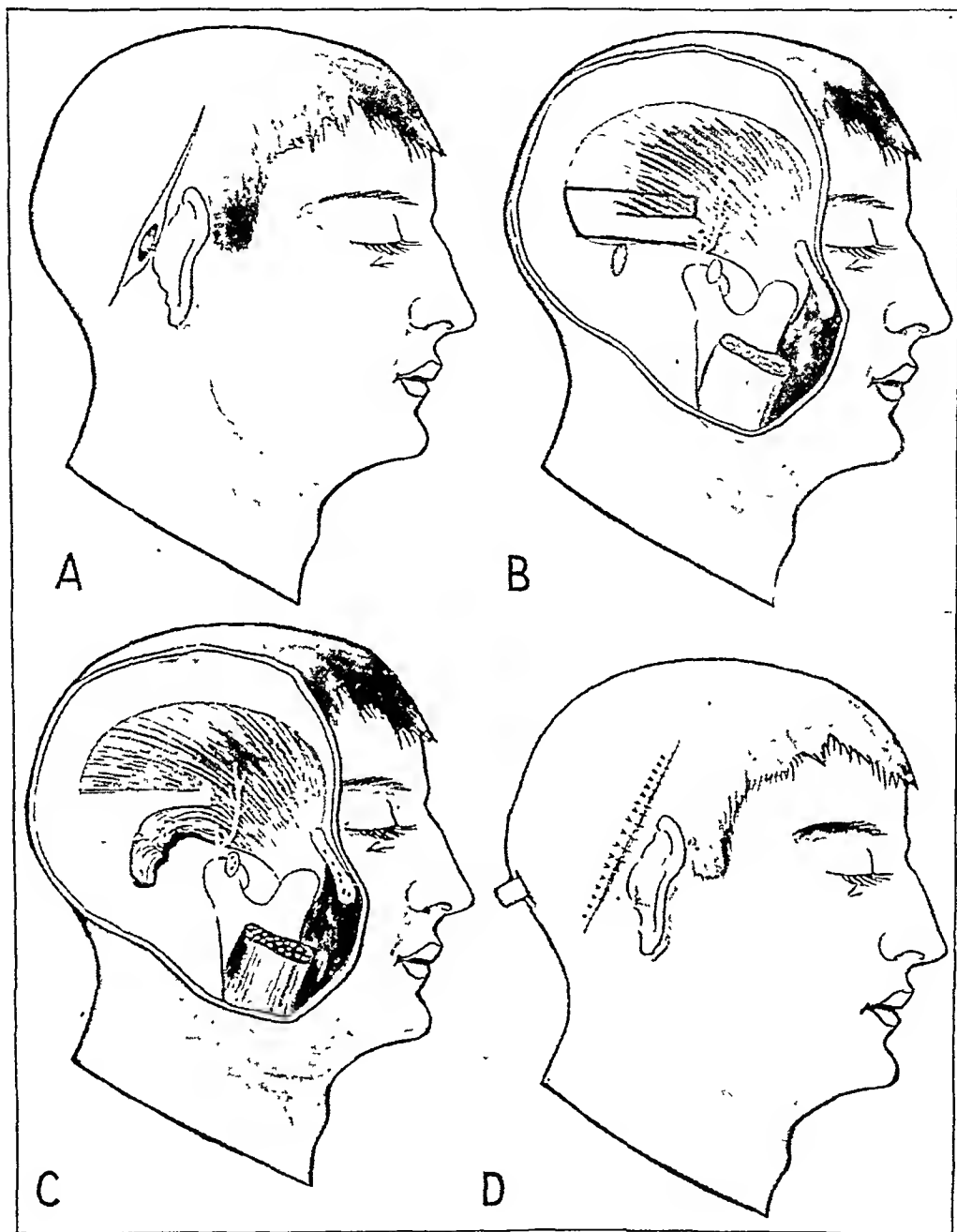
After this is done the actual construction of the muscle flap is started. The temporal muscle is clearly exposed in its posterior inferior origin. The fibers should be clearly visible as far anteriorly as a point directly superior to the tragus. An incision is next made through the fascia and the muscle down to the bone, extending from the most posterior-inferior portion of the muscle horizontally forward to a point directly above the anterior-superior attachment of the ear. This will be the inferior portion of the muscle flap.

Another incision is now made from 2 to 5 cm. above and parallel to the original incision. This too is carried directly down to the bone and reaches anteriorly to a point directly above the forward tip of the first incision.

Next the muscle between the two incisions is freed from the underlying bone as far anteriorly as the incisions extend and posteriorly well toward the superior temporal line, care being taken not to free the flap. At a point midway between the two incisions, in their anterior aspect, still another incision is made parallel to the original one. This is carried posteriorly to a point at least midway in the flap, the actual extent depending largely on the size of the defect to be filled.

At this stage the posterior division of the middle temporal artery should be contained within the lower division of the muscle flap (fig., *B*).

The muscle flap is cut completely free from its posterior attachment, and the amount of lengthening needed is estimated. The extent of splitting of the flap is determined by the actual amount of tissue necessary to restore contour. The superior-anterior portion of the flap is next cut free, and it will be found that by



*A*, direction and extent of the incision. The epithelial remnants are completely removed in the region of the defect. *B*, outline of the muscle flap, showing the contained posterior division of the middle temporal artery. The superficial temporal artery is shown only at its margin. *C*, flap liberated and rotated into the region of the defect, carrying with it the artery. *D*, complete closure of the initial incision, with a drain in the dependent portion of the scalp flap.

rotating this portion of the muscle it can be made to reach the defect even though there is some distance between the attachment of the flap and the defect (fig., *C*). It is so rotated as not to impair its blood supply.

The periosteal portion of the flap is allowed to remain on the surface instead of an attempt being made to twist it so that it fits next to the bone. The work of Levander<sup>18</sup> is cited to substantiate our impression that the periosteum per se is not important in the procedure. The flap is not further incised nor mutilated in any manner that may cause excessive scarring, which might increase the possibilities of absorption.

The flap is fitted into its new position with the contour slightly overcorrected. If the correction is for a defect following radical mastoidectomy the muscle is made to fill the defect well into the middle ear, but the lumen of the canal is maintained by means of a gauze pack inserted through the external auditory meatus. The muscle flap is firmly packed against this. The muscle itself is anchored so that there are no "dead spaces," the fascia over the muscle being utilized and sutures being passed through it into the fascia and periosteum in the surrounding area.

The primary incision is closed tightly with no drains, and every attempt is made to get satisfactory apposition of the skin in the approved manner. A stab incision is made well posteriorly and in the most dependent portion of the liberated flaps (fig., *D*). This is well within the hair line, and in this site a plain rubber drain is inserted to allow the escape of blood from any hemorrhage under the flaps. This leaves only a small scar that will eventually be covered with hair.

A model of the ear, in two parts, is made of dental compound. The anatomic position of the ear must be preserved and the postauricular sulcus maintained. The model is also fitted into the external auditory canal and made to conform to the uneven contour of the ear. This is in turn smoothed over on the surface, so that a large dressing may be applied, exerting pressure equally over the ear, the postauricular defect and the flaps in their entire extent.

The presence of a small pack to maintain the lumen of the external canal in cases of repair following radical mastoidectomy is most important. A wick saturated with a 70 per cent solution of alcohol has been employed with success for this purpose.

The rather complicated dressing is justified because the pressure, which is of paramount importance, prevents the cartilages of the ear from being forced into the region of the graft.

#### EXPERIENCE WITH THE OPERATION

In three years this operation has been successfully employed in 15 cases. All the patients had been previously operated on one or more times, and 1 had had eleven unsuccessful attempts at closure.

In this series of cases no infection has been encountered to cause a breaking down of the wound, and, as before stated, this is attributed largely to the freedom of the skin flaps and to the proper preparation of the muscle flap with its contained artery. In no case was it found necessary to make a relaxing incision for proper closure.

#### SUMMARY

1. A brief review of the literature pertaining to the procedures for the correction of postauricular defects is given.

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18. Levander, G.: A Study in Bone Regeneration, Surg., Gynec. & Obst. 67: 705, 1938.

2. A more detailed study of the blood supply of the temporal muscle, as found in injected and in uninjected human specimens, is described. The posterior division of the middle temporal branch of the superficial temporal artery is found to be in a position to allow the construction of a flap from the temporal muscle carrying a dependable blood supply for the correction of postauricular defects.

3. A "radical" operation for the closure of large postauricular defects is described in detail. This operation is based on a series of 15 cases, in all of which repair was successfully performed by this method after one or more previous unsatisfactory attempts at closure by one or several of the conservative methods described.

# NATURE OF VITAMIN B AND ITS COMPONENTS

WITH SPECIAL REFERENCE TO NERVE DEAFNESS

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The accumulated total of human knowledge is incomprehensible. A few hundred years ago an aspiring scientist took all knowledge as his province, but the ever mounting mass of information necessarily led to specialization. The inevitable penalty of working in a restricted field is ignorance of progress outside one's special domain until some significant overlapping necessitates inquisitive excursions abroad. The possible relation between deficiency of vitamin B and at least some forms of nerve deafness, pointed out by Selfridge,<sup>1</sup> and an attempt to alleviate a condition heretofore largely intractable entail certain questions which must be answered if therapeutics is to have some semblance of rationality. What is the chemical and biologic nature of this complex catalyst? Can a symptomatic picture be formulated so that the need for it can be diagnosed clinically? Are there any laboratory procedures to aid investigators? What are the meanings of the new names and standards of measurement occurring in published reports? To answer these and other questions extensive search of the literature through the 1937 volume of the *Quarterly Cumulative Index Medicus* was undertaken. The information on vitamins, particularly vitamin B, was found to be in a chaotic state of flux and so voluminous that a really complete survey would be impossible. The following paper is written in the hope that the material here presented will obviate the necessity of much collateral reading on the part of others.

## HISTORICAL DATA

Beriberi was known to the Chinese in 2600 B. C.,<sup>2</sup> and, of course, scurvy was the greatest hindrance to maritime exploration in the great era of geographic expansion. It is interesting that the celebrated Cook

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Presented as a candidate's thesis to the American Laryngological, Rhinological and Otological Society, May 1939.

1. Selfridge, G.: Eighth Nerve High Tone Deafness from the Nutritional Standpoint, *Ann. Otol., Rhin. & Laryng.* **46**:93-118 (March) 1937.

2. Rose, M. S.: *The Foundations of Nutrition*, New York, The Macmillan Company, 1938.

attributed the latter to dietary faults, and a Japanese naval officer in 1872 reduced the incidence of the former by an improved dietary regimen. In 1881 N. Lunin<sup>3</sup> postulated the vitamin theory on his observation that proteins, fats, carbohydrates and mineral substances were insufficient to support life. Eijkman in 1897 concluded that beriberi is a disease produced by the toxicity of polished rice, but Grijns in 1901 arrived at the conception that a deficiency is at fault. According to Booth and Hansen,<sup>4</sup> "Funk in 1912 proposed the name 'vitamin' for the substance derived from rice polishings which cured beri-beri." Independently McCollum and Davis in this country (in 1914) found a water-soluble substance necessary for growth which proved to be identical with Funks'. This water-soluble substance was termed vitamin B in distinction to the fat-soluble element called vitamin A. Through conflicting biologic experiments it soon became apparent that B is not an entity but a collection of compounds with various chemical and biologic properties.<sup>5</sup>

#### NATURE OF VITAMIN B

At the present time the following subdivisions of the B group are recognized.<sup>6</sup>

B<sub>1</sub>, thiamin<sup>7</sup> (aneurin or torulin), is the antineuritic vitamin. It has been extracted in pure form from natural sources and has been synthesized. It is a complex sulfur, nitrogen and carbon ring compound and forms with hydrochloric acid a white crystalline solid, which is water soluble.<sup>4</sup> It is relatively heat resistant when dry but is rapidly destroyed at 100 C. when moist, especially in neutral or alkaline mediums. In acid mediums it is much less affected by heat.<sup>7a</sup>

Its particular biochemical activity<sup>8</sup> is as an essential catalyst in the combustion of carbohydrate, the oxidation being carried to the lactic acid-pyruvic acid stage and there arrested. Pyruvic acid does not appear

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3. Cited by Addinall.<sup>19b</sup>

4. Booth, M., and Hansen, A. E.: Present Day Status of Vitamins: Review, *Journal-Lancet* **57**:530-544 (Dec.) 1937.

5. Jones, D. B.: A Summary of Our Present Knowledge of Vitamins, United States Department of Agriculture, Bureau of Chemistry and Soils, September 1932. Mendel, L. B., and others: *The Vitamins: A Symposium on the Present Status of the Knowledge of Vitamins*, Chicago, American Medical Association, 1932.

6. (a) Peters, R. A.: Vitamin B Complex, *Brit. M. J.* **2**:903-905 (Nov. 7) 1936. (b) Lepkovsky, S.; Jukes, T. H., and Krause, M. E.: Multiple Nature of Third Factor of Vitamin B Complex, *J. Biol. Chem.* **115**:557-566 (Sept.) 1936.

7. (a) Williams, R. R.: The Chemistry of Thiamin (Vitamin B<sub>1</sub>), *J. A. M. A.* **110**:727-732 (March 5) 1938. (b) Riboflavin, the Accepted Name for Vitamin B<sub>2</sub>, report of the Council on Pharmacy and Chemistry, *ibid.* **108**:1340-1341 (April 17) 1937.

8. Peters, R. A.: Biochemical Lesion in Vitamin B<sub>1</sub> Deficiency, *Lancet* **1**:1161-1165 (May 23) 1936.

in normal brain tissue but is found in such tissues of animals suffering from a deficiency of  $B_1$  and in large quantities also in the blood of patients with beriberi. The addition of  $B_1$  to the brain tissue in vitro causes a continuation of the combustion. This is the only evidence in vitro of the action of vitamins.

Thiamin is stored in the liver, kidneys and brain, but not for long, and is eliminated in the urine and feces.<sup>9</sup> It is not toxic when ingested in large quantities.<sup>7a</sup>

The term B complex refers to all the water-soluble vitamins together and therefore does not designate a chemical entity.  $B_2$  (in England), or G (in the United States), is riboflavin ( $C_{17}H_{20}N_4O_6$ ) (not to be confused with flavones, which are allied to plant pigments or with such substances as acriflavine) and is related to the purines, pyrimidines and nucleotides. It is identical with the yellow oxidation enzyme of Warburg. It is destroyed by visible light,<sup>4</sup> especially the blue-violet portion, and by alkalis and is fluorescent in the presence of ultraviolet radiations. It is soluble in water, insoluble in alcohol and heat stable. It rotates the plane of polarized light. It has been obtained pure both from natural sources and by synthesis (Enler, 1934<sup>10</sup>) and cannot be synthesized in the animal body. It has been demonstrated to unite with a protein to form an enzyme. Its biochemistry has not been elucidated, but it is necessary for life, and its absence is probably not the cause of human pellagra.

The remaining fractions are characterized chiefly by the symptoms produced by their absence from the diets of experimental laboratory animals, little being known of their chemical nature:

$B_3$ , the existence of which is doubtful,<sup>6a</sup> is said to be necessary for growth in pigeons. Its necessity for man has not been established.<sup>11</sup>

$B_5$  is usually described with  $B_3$ , and between them they include the chicken antipellagra factor.  $B_5$  is alkali and heat stable and is necessary for the nutrition of pigeons<sup>12</sup> but is of questionable status.<sup>11</sup>

$B_4$  also is obscure.<sup>6a</sup> It is perhaps a variation of  $B_1$ .<sup>4</sup> Its absence causes paralysis, encephalomalacia and ataxia in animals. It is water soluble, labile and easily destroyed by oxygen.<sup>12</sup> It is not abundant in foods.<sup>11</sup>

$B_6$  is also known as H, or the Y factor of György.<sup>13</sup> It is usually termed the rat antidermatitis fraction.<sup>6a</sup> Its absence causes a specific

9. Gutman, J.: Modern Views on Vitamins and Treatment of Nutritional Disorders, *M. Rec.* **146**:129 (Aug. 4); 228 (Sept. 1) 1937.

10. Enler, cited by Rose.<sup>2</sup>

11. Wilder, R. M., and Wilbur, D. L.: Diseases of Metabolism and Nutrition: Review of Certain Recent Contributions, *Arch. Int. Med.* **59**:512-555 (March) 1937.

12. Elvehjem, C. A.: Present Status of Vitamin B Complex, *Am. J. Pub. Health* **25**:1334-1339 (Dec.) 1935.

13. Cited by Schultz, H. W., and Mattill, H. A.: Studies on Vitamin B Complex, *J. Biol. Chem.* **122**:183-198 (Dec.) 1937.

disease in rats characterized by dermatitis of the ears, nose and paws, a bloody mouth and a spectacled loss of hair around the eyes. It is relatively stable to heat and alkali. It is found in liver with vitamin B<sub>1</sub> but occurs in fish and cereals, which are poor in B<sub>1</sub>. Deficiency of it may be related to pernicious anemia and agranulocytosis in rats.<sup>1</sup>

The following also are mentioned: the P-P. fraction, the human anti-pellagra fraction, or nicotinic acid;<sup>4</sup> the dog black tongue fraction; the pigeon heart block fraction; a catalyst for growth of molds and micro-organisms; factor 2, an essential for growth, equivalent to the precipitate factor of Elvehjem, Koehn and Olson<sup>13</sup> and probably identical with one of those previously mentioned, and vitamin E, deficiency of which is related to sterility in rats, which may possibly be a component of the B complex.<sup>2</sup>

From a practical standpoint, then, one has to deal with vitamin B<sub>1</sub>, or thiamin; G (B<sub>2</sub>), or riboflavin; nicotinic acid; vitamin B<sub>6</sub>, which has been isolated but not identified, and a group of less well known substances which comprise the remainder of the complex.

#### SYMPTOMS OF DEFICIENCY OF VITAMIN B

*Vitamin B<sub>1</sub>.*—In laboratory animals (rat and pigeon) absence of B<sub>1</sub> leads to anorexia, loss of weight, polyneuritis, peculiar convulsions and a specific bradycardia in rats,<sup>6a</sup> due to the toxic effect of pyruvic acid on the cardiac muscle.<sup>14</sup> The vitamin is necessary for growth in the young and health in adults. Disturbance of intestinal function, failure of lactation and atrophy of the gonads are reported.<sup>4</sup>

Severe deficiency of B<sub>1</sub> in man causes beriberi,<sup>4</sup> of which the principal symptoms are as follows:

(a) Peripheral neuritis, with paralysis of the extremities, muscular atrophy and edema.

(b) Vasomotor symptoms, i. e., palpitation of the heart, dyspnea and enlargement of the right side of the heart.

Observed symptoms in experimental B deficiency as reported by Elsom<sup>15</sup> are as follows (symptoms reported by others are interpolated and the reference given):

1. Gastrointestinal symptoms include loss of appetite, the most frequently mentioned symptom;<sup>15</sup> sore tongue; heart burn, and abdominal fulness, constipation or diarrhea. Roentgen examination has shown atonicity of the stomach and changes in peristalsis. Some observers<sup>15</sup>

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14. Harris, L. J., and Leong, P. C.: Vitamins in Human Nutrition: Excretion of Vitamin B<sub>1</sub> in Human Urine and Its Dependence on Dietary Intake, *Lancet* **1**: 886-894 (April 18) 1936.

15. Elsom, K. O.: Practical Aspects of Deficiency, *M. Clin. North America* **21**:1229-1244 (July) 1937.



have reported changes in the gastric hydrochloric acid, while others<sup>4</sup> have not found any departure from normal. There is evidence of impaired absorption of protein. Ulceration of the gastrointestinal tract, which, however, might be a cause of the deficiency rather than a result, has been reported,<sup>17</sup> as has swelling of the lymphoid patches in the ileum.<sup>9</sup> Narat and Losf<sup>18</sup> could not demonstrate stimulation of peristalsis by pure B<sub>1</sub> concentrates.

2. Neurologic symptoms are paresthesias, especially of the lower extremities, and impairment, and later loss, of vibratory sense in the toes. Polyneuritis has been observed, especially in alcoholism but also in pregnancy, diabetes and states of malnutrition.<sup>4</sup>

The primary neurologic lesion is apparently functional and due to faulty combustion of carbohydrates, resulting in a toxic accumulation of pyruvic acid. The microscopically demonstrated degeneration of the myelin sheaths is a secondary change.<sup>19</sup>

3. Cardiovascular symptoms are variable and not striking in moderate states of deficiency according to Elsom,<sup>15</sup> who reported dyspnea and persistent tachycardia. Others<sup>20</sup> reported vague reflex irritability, with bradycardia, asystole or syncope. No electrocardiographic changes were noted in one report,<sup>15</sup> while another<sup>11</sup> stated that changes in the T wave in 35 of 38 cases disappeared with B<sub>1</sub> therapy. The same observers reported dilatation of the peripheral arterioles with vasomotor collapse or vasoconstriction. Hypotension and failure of the right<sup>15</sup> or left<sup>11</sup> side of the heart have been seen in severe states. (The discrepancies in this account are apparently due to deficiencies of vitamin B of widely varying severity.)

4. Hematologic symptoms include macrocytic anemia similar to the pernicious form, which has been demonstrated in pregnant women. Ecchymoses of the lower extremity without trauma have been noted.

5. Edema is a prominent symptom and is present without sufficient renal or cardiac damage to explain it.

Other effects of deprivation of B<sub>1</sub> are said to be susceptibility to fatigue,<sup>15</sup> mental hebetude,<sup>9</sup> retardation of growth and development,<sup>4</sup> failure of lactation,<sup>4</sup> retinal hemorrhages, optic neuritis<sup>21</sup> and perhaps diseases of the ocular muscles.<sup>11</sup>

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16. Footnote deleted.

17. Mackie, T. T.: *Ulcerative Colitis: Factor of Deficiency States*, J. A. M. A. **104**:175-178 (Jan. 19) 1935.

18. Narat, J. K., and Losf, J. A.: *Effects of Vitamin B<sub>1</sub> Concentrate (on Peristalsis and Blood Pressure)*, Arch. Int. Med. **60**:449-453 (Sept.) 1937.

19. (a) Booth and Hansen.<sup>4</sup> (b) Addinall, C. R.: *The Story of Vitamin B<sub>1</sub>*, Rahway, N. J., Merck & Co., Inc., 1937.

20. Cited by Wilder and Wilbur.<sup>11</sup>

21. Booth and Hansen.<sup>4</sup> Wilder and Wilbur.<sup>11</sup>

Vitamin B<sub>1</sub> is said to be helpful in the treatment of herpes zoster ophthalmicus, neurosis of the sphenopalatine ganglion.<sup>22</sup> and certain forms of neuritis.<sup>23</sup>

*Riboflavin*.—Laboratory animals deprived of vitamin G (B<sub>2</sub>) show retarded growth and loss of weight. Symptoms resembling scurvy and formation of cataracts have been reported in rats.<sup>4</sup> Dogs on certain diets deficient in vitamin G (B<sub>2</sub>) showed marked demyelination of the peripheral nerves, the anterior and posterior spinal nerves and the posterior column.<sup>6a</sup>

In man the symptoms of riboflavin deficiency are not known.<sup>4</sup> It is presumed to be a dietary essential, and comparisons with deficiency states in laboratory animals have been made, but the results are largely conjectural.

Considering the whole so-called vitamin G (or B<sub>2</sub>) complex (riboflavin, vitamin B<sub>6</sub> and the P-P factor, which has since been identified as nicotinic acid), Booth and Hansen<sup>4</sup> gave the following symptoms of deficiency in man:

1. Pellagra—due probably to avitaminosis P. P. . . . .

Brown, scaly, symmetrical dermatitis in exposed areas, glossitis, soreness of mouth, indigestion, diarrhea, and disturbances of the nervous system—at times leading to dementia.

2. Acrodynia—believed by some to be caused by the lack of one or more of the factors in vitamin B complex [here including riboflavin]. Because of its cutaneous manifestations, acrodynia is often mentioned in connection with vitamin B<sub>2</sub> complex.

Irritability, insomnia, appearance of misery, anorexia, acrocyanosis, itching and burning of hands and feet, desquamation of palms and soles, marked perspiration, photophobia, muscular hypotonicity, increased blood pressure, and loss of teeth.

*Relation with Endocrine Glands*.—There are many suggestions of a relation between vitamin B and the endocrine glands. Booth and Hansen<sup>4</sup> stated that it is definitely linked with hormones. It may be related to the pituitary body and the adrenal cortex.<sup>24</sup> It is one of the essential elements of the thyro-adrenopituitary group.<sup>22</sup> It is related to the endocrine secretions in rats.<sup>25</sup> Meurlin<sup>25b</sup> in a recent article stated that large amounts of thyroxin counteract the good effects of vitamin B<sub>1</sub> in rats and that, conversely, large amounts of vitamin B<sub>1</sub>, because of the increase in metabolism, serve to offset the effects of thyroxin. He

22. Koepcke, G. M.: Vitamins and Infections of Eye, Nose, Throat and Sinuses. *Journal-Lancet* 57:460-462 (Oct.) 1937.

23. Stevenson, D.: Vitamin B<sub>1</sub> in the Treatment of Neuritis. *Practitioner* 140: 301-306 (March) 1938.

24. Selfridge, G.: Chronic Progressive Deafness, Mid-Winter Clinical Course of the Research Study Club, Los Angeles, 1938, privately printed.

25. (a) Rose.<sup>2</sup> (b) Meurlin, J. R.: Vitamins and Hormones, *J. Am. Dietet. A.* 14:397-411 (June-July) 1938.

stated also that thiamin is synergistic to insulin in certain persons with diabetes but antagonistic in others. It is antagonistic to the diabetogenic hormone of the anterior lobe of the pituitary body. Some member of the B group other than riboflavin or thiamin has the power to prevent adrenal hypertrophy, which usually follows severe muscular exercise in certain animals.

*Rhinologic and Otologic Symptoms.*—A syndrome of vitamin B deficiency (fraction not determined) with special reference to rhinology was presented by Cody<sup>26</sup> in 1932. He listed the following symptoms:

The complaint is a slight but frequent post-nasal discharge. . . . Sneezing is occasional but not in bouts. . . . Young women are more often affected. . . . The nasal mucosa on anterior inspection is . . . normal, except over the middle turbinates. Posteriorly, the tips of the turbinates have a smooth, moist, creamy-white appearance. . . . Mucus is seen in various locations, but not regularly in any one place.

It is noteworthy that nowhere was deafness mentioned except in Selfridge's articles (with one inconclusive exception),<sup>27</sup> but it certainly should be included as one of the possible clinical manifestations of deficiency of vitamin B. Kagawa and Naito<sup>28</sup> made no mention of deafness or of the eighth nerve in their report of experimental studies of B<sub>1</sub> deficiency in man. Analyzing Selfridge's case histories one finds that the other symptoms in his 14 cases of high tone deafness which improved with various forms of B therapy were as follows: low basal metabolism rate, in 8 cases; tinnitus, in 4; fatigue, in 3, low blood pressure, in 3; gastrointestinal disturbances, in 3; edema of Cody, in 2; dizziness, in 2; aural discharge, in 2, and allergy, loss of weight and vomiting, in 1 each. Aside from the symptoms referable to the ear, the clinical picture is one of low basal metabolism rate, with the patient below par, possibly with low blood pressure and gastrointestinal difficulties.

*Summary of Symptoms.*—In general, then, taking into consideration all the reported clinical data, one may say that a vitamin B-deficient person may have symptoms referable to the nervous, vascular or gastrointestinal system, the endocrine glands or the organs of special sense, will not have any pathognomonic lesion or syndrome and will be below par and in real danger of being relegated to the clinical limbo of "neurasthenic" patients.

26. Cody, C. C., Jr.: The Relation of Vitamins A, D, B and G to Otolaryngology, Tr. Am. Laryng., Rhin. & Otol. Soc. **38**:289-305, 1932.

27. Shambaugh, G. E., Jr.: Chronic Progressive Deafness Including Otosclerosis and Diseases of the Inner Ear, Arch. Otolaryng. **26**:583-605 (Nov.) 1937.

28. Kagawa, S., and Naito, H.: Die experimentelle B<sub>1</sub>-Avitaminose beim Menschen, Jap. J. M. Sc., VIII, Int. Med., Pediat. & Psychiat. **4**:128\*-129\* (Feb.) 1936.

*Laboratory Methods.*—A syndrome by which to identify the patient in need of vitamin B therapy not being found, a search was made for a laboratory procedure which could be used to distinguish B-deficient persons. Harris<sup>29</sup> established that a 140 pound (63.5 Kg.) man excreting less than 12 international units of vitamin B<sub>1</sub> per day in the urine and failing to increase his urinary output if given a dose of 500 international units is suffering from a deficiency. Peters<sup>6a</sup> also stated that the urinary output of thiamin is diminished in the presence of a deficiency. Harris and Leong<sup>20</sup> gave the daily urinary output of a normal person as 12 to 35 international units, with an average of 20, which equals 5 to 8 per cent of the intake. Meiklejohn<sup>20</sup> gave the normal blood value of man as 4 international units per hundred cubic centimeters.

Now these values are precise, but difficulty is experienced in attempting to find out if one's patient comes up to the norm.

Harris and Leong<sup>14</sup> determined the B<sub>1</sub> content of the urine by a method which involved examination of a twenty-four hour specimen, adjustment to  $p_H$  5 (bromocresol green indicator), extraction twice with claret acid clay (a form of fuller's earth) and biologic assay of the extract by quantitative feeding to B<sub>1</sub>-deficient rats in which specific bradycardia had been produced sufficient to cause a fall in the electrocardiographic reading from 500 to 370 or 390. The time required for the heart rate to return to normal was the quantitative index, which was then compared with the amount of B<sub>1</sub> given certain normal control rats.

Roscoe<sup>30</sup> used a biologic method with vitamin B<sub>1</sub>-deficient rats with neuritis and vitamin G (B<sub>2</sub>)-deficient rats showing lack of growth. Using urine concentrates she concluded there was no relation between the presence or absence of vitamin B fractions in the urine of normal controls and the adequacy of the dietary intake.

Helmer,<sup>31</sup> studying human urine, used deprived rats for biologic assay.

Peters<sup>8</sup> used the restoration of avitaminotic brain tissue in vitro.

Arakawa<sup>32</sup> developed a colorimetric test for the milk of lactating women.

Schultz, Atkin and Frey<sup>3</sup> used the catalytic action on alcoholic fermentation.

Johnson<sup>33</sup> worked on the isolation of pyruvic acid in B<sub>1</sub>-deficient pigeons. The following summary shows how elaborate the technic is:

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29. Harris, L. J.: A Programme for Nutrition Surveys, *Lancet* **1**:966-968 (April 25) 1936.

30. Roscoe, M. H.: B-Vitamins in Human Urine, *Biochem. J.* **30**:1053-1065 (June) 1936.

31. Helmer, O. M.: Vitamin B<sub>1</sub> and B<sub>2</sub> Content of Human Urine, *Proc. Soc. Exper. Biol. & Med.* **32**:1187-1188 (April) 1935.

32. Cited by Booth and Hansen.<sup>4</sup>

33. Johnson, R. E.: Isolation of Pyruvic Acid from Blood of Vitamin B<sub>1</sub>-Deficient Pigeons, *Biochem. J.* **30**:31-32 (Jan.) 1936.

After three preliminary procedures the blood precipitates stand for a week with a 0.6 per cent solution of 2,4-dinitrophenylhydrazine. Then follow multiple adjustments of the  $p_H$  and extraction with sodium phosphate, five washings with hydrochloric acid and one with distilled water. This is followed by distillation in vacuo. The residue then undergoes multiple extractions, precipitations, washings and crystallizations, including three more distillations in vacuo. A bit elaborate for routine practice!

Meiklejohn,<sup>34</sup> for estimation of thiamin in the blood, used a modification of Schopfer's test, which is based on the catalytic action of  $B_1$  for the growth of certain strains of molds.

Prebluda and McCollum<sup>35</sup> have developed a specific, sensitive chemical reagent which produces a purple-red compound with thiamin, which, they stated, is suitable for qualitative and quantitative estimation, but I did not find a technic practicable for routine clinical use.<sup>36</sup>

Westenbrink and Goudsmit<sup>37</sup> have developed a chemical method of quantitative determination of thiamin (aneurin) in urine by the thiochrome reaction (chemical conversion of thiamin to thiachrome). The procedure is somewhat elaborate and has certain phases in which inaccuracies may occur, and the final colorimetric reading is galvanometric, the norm being ascertained by running several specimens of urine to which known amounts of thiamin have been added. This is a step in the right direction, as it does away with deficient and control laboratory animals, but for routine use a simpler and more fool-proof procedure is necessary.

I conclude, then, that, as Helmer<sup>31</sup> stated in 1935 and Elsom<sup>15</sup> in July 1937, no satisfactory clinical test has been devised.<sup>38</sup>

#### STANDARDS OF MEASUREMENT

The literature on vitamin B contains references to many different units based on the potency of a clay adsorbate to relieve the symptoms of deficient laboratory animals. Since thiamin has been isolated and synthesized, future measurements of  $B_1$  will undoubtedly be made in weight of pure thiamin chloride crystals. However, at the present time

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34. Meiklejohn, A. P.: Estimation of Vitamin  $B_1$  in Blood by a Modification of Schopfer's Test, *Biochem. J.* **31**:1441-1451 (Sept.) 1937.

35. Prebluda, H. J., and McCollum, E. V.: Chemical Reagent for Detection and Estimation of Vitamin  $B_1$ , *Science* **84**:488 (Nov. 27) 1936.

36. Naiman, B.: A Reagent for Vitamin  $B_1$ , *Science* **85**:290 (March 19) 1937.

37. Westenbrink, H. G. K., and Goudsmit, J.: The Determination of Aneurin (Vitamin  $B_1$ ) in Urine by the Thiochrome Reaction, *Rec. d. trav. chim. d. Pays-Bas* **56**:7, 1937.

38. Clark, G. W.: Personal communication to the author. Hunsberger, A., Jr.: Personal communication to the author. Weigand, C. G.: Personal communication to the author.

it is necessary to have some means of comparing quantities, or rather potencies, expressed in different standards. The following definition, by Addinal,<sup>19b</sup> supplemented from other sources, is only approximate but contains the mean results of various competent investigators:

The international unit, adopted in 1934 by the Conference on Vitamin Standardization, is based on the potency of a clay adsorbate of an aqueous extract of rice polishings as tested for promotion of growth in deficient rats and cure of retraction of the head in deficient pigeons. It is typical of the hazards under which biochemists have labored that the daily dose of this "standard" preparation necessary to cure a rat is 10 to 20 mg. and that to cure a 300 Gm. pigeon 10 to 30 mg. This is considerable spread for a standard unit.

One international unit is equivalent to the following values:

3.333	micrograms of thiamin chloride
0.5	Smith curative unit
2.0	Sherman-Chase units
1.0	Roscoe unit
20.0	Cowgill milligram equivalents

This is the usual standard for pharmaceutical houses in the United States, the basis being 1 Gm. of thiamin chloride equals 300,000 international units.

The following observers, however, gave values for 1 international unit as follows: Peters,<sup>6a</sup> 2 to 4 micrograms of thiamin chloride; Harris and Leong,<sup>20</sup> 2 micrograms; Ohdake and Yamagishi,<sup>39</sup> 1 microgram; Elvehjem,<sup>12</sup> 3 micrograms and Ammerman and Waterman,<sup>39</sup> using Williams' crystals, 5 micrograms. Rose<sup>2</sup> stated that 1 Sherman-Chase unit equals 2.5 micrograms of thiamin chloride.

Vitamin G (or B<sup>2</sup>) is measured in Sherman-Bourquin units, which are biologic units based on the growth of rats. So far as I know, this unit has not been converted into weight of riboflavin crystals.

#### REQUIREMENTS IN MAN

Cowgill,<sup>40</sup> realizing that the thiamin requirement is related to caloric intake and body weight, evolved the following formula, which has been widely quoted:  $\frac{\text{vitamin B milligram equivalent}}{\text{caloric needs}} = 0.0000284 \times W$ , in which  $W$  = body weight in grams. (One milligram equivalent of B<sub>1</sub> = 1/20 international unit.) When resolved for a man weighing 70 Kg., on a diet of 3,000 calories, the result is 300 international units per day. This is accepted by Gutman.<sup>9</sup> Jansen<sup>32</sup> in 1934 placed the daily adult require-

39. Cited by Elvehjem.<sup>12</sup>

40. Cowgill, G. R.: *The Vitamin B Requirements of Man*, New Haven, Conn., Yale University Press, 1934.

ment at 200 international units; Vorhaus in 1935, at 4,000 Sherman units; Harris in 1936, at about 1 mg. of crystalline thiamin chloride, and the Council on Pharmacy and Chemistry of the American Medical Association the same year, at 50 international units for children and 200 for adults. In 1937 Wilder and Wilbur<sup>11</sup> gave the value as 10 to 20 mg. of thiamin chloride. Rose<sup>2</sup> gave it as 10 Sherman-Chase units per 100 calories per day for adults and the same ratio for children. Peters<sup>6a</sup> put the adult daily requirement at 250 to 500 international units, or 1 mg. of crystalline thiamin chloride. Elsom<sup>15</sup> in 1937 estimated the minimum human requirement at 1,000 Sherman units per day, with the optimum intake at five times as much. Borsook<sup>41</sup> concluded that the minimum vitamin B<sub>1</sub> required to avoid beriberi is 1 international unit per pound (0.5 Kg.) of body weight per day and the optimum for health 5 to 7 international units per pound (0.5 Kg.) per day. It is generally agreed that the desideratum for health is about five times the minimum required to prevent beriberi.<sup>42</sup>

By assuming the subject to be on a 3,000 calorie daily diet and converting the values given into milligrams of crystalline thiamin chloride, one arrives at the following estimated daily requirements:

	International Units		Mg. of Crystalline Thiamin Chloride
Peters, Cowgill, Gutman, Harris.....	300	=	1.0
Jansen, American Medical Association.....	200	=	0.66
Borsook (minimum).....	150	=	0.5
Borsook (optimum).....	750 to 1,000	=	2.5 to 3.5
Sherman Units			
Vorhaus.....	4,000	=	6.6
Wilder and Wilbur.....		=	10.0 to 20
Rose.....	300	=	0.5
Elsom (minimum).....	1,000	=	5.0
Elsom (optimum).....	5,000	=	25.0

At the risk of criticism for a facetious remark I cannot refrain from pointing out that these values, translated into loaves of white bread, mean a spread in daily consumption per person of from one and one-half to seventy-five! However, the general consensus seems to place the daily requirement at 300 international units, or 1 mg. of thiamin chloride, and Booth and Hansen<sup>4</sup> and others have stated that there are no ill effects from ingestion of many times this amount. It is, however, repeatedly stated in the literature<sup>43</sup> that lack of vitamin B is the

41. Borsook, cited by Smith.<sup>43b</sup>  
42. Elsom,<sup>15</sup> Cody.<sup>26</sup>  
43. (a) Elsom.<sup>15</sup> (b) Smith, H. A.: Personal communication to the author. (c) Selfridge, G.: Chronic Progressive Deafness from a Nutritional Standpoint: Preliminary Report, *Ann. Otol., Rhin. & Laryng.* 46:875-894 (Dec.) 1937. (d) Other writers, too numerous to cite.

most glaring fault of the modern dietary, not only because of insufficient food for the poorer classes but from an overly refined diet among all classes. Borsook<sup>41</sup> stated the belief that principally because of the polishing of grain the average American receives only slightly more than the daily minimum. Sure<sup>42</sup> has stated that one third of the population of the country is under par from the standpoint of nutrition.

Certain conditions are known to modify the requirement of vitamin B<sub>1</sub>: It is increased by a high intake of carbohydrate and is spared by high ingestion of fat.<sup>15</sup> It varies with the species and with the individual.<sup>15</sup> It is greater<sup>2</sup> in the presence of infection, fever, diabetes,<sup>45</sup> hyperthyroidism, pregnancy, exercise, a high basal metabolic rate, lactation, an unusual gain in weight, elderliness in women, a postoperative state and any gastrointestinal condition causing poor absorption, such as colitis, diarrhea, pyloric stenosis or achlorhydria.<sup>15</sup> The content of the diet may be adequate but utilization by the subject insufficient. Not only is the total ingestion important, but the concentration of thiamin in the diet influences its utilization.<sup>15</sup>

In regard to the requirements of riboflavin, Copping and Roscoe<sup>46</sup> stated: "There are at present [August 1937] no data available for calculating human requirements of vitamin B<sub>2</sub> complex." It is related to the protein intake.<sup>4</sup> An adequate intake has been estimated tentatively by Rose<sup>2</sup> and Daniel and Munsell<sup>47</sup> at 600 Sherman-Bourquin units for adults and 400 for children up to 10 years of age. Rose believes the optimum to be about four times the minimum necessary.

#### NATURAL SOURCES

The usual method of arriving at an assumption of deficiency of vitamin B is analysis of the dietary intake. The following table lists the most potent sources of vitamins B<sub>1</sub> and G (B<sub>2</sub>) and the content of the commoner foods, in the approximate order of richness. It is compiled from tables in Addinall's publication<sup>19b</sup> and Rose's book<sup>2</sup> and from tables in the publication of Daniel and Munsell.<sup>47</sup> In Addinall's publication the figures were given for international units of thiamin per ounce (28.3 Gm.). In Rose's table (which is much more extensive than the list here submitted) the values for B<sub>1</sub> were expressed in

44. National Institute of Nutrition: Personal communication to the author.

45. Wilder, R. M., and Wilbur, D. L.: Diseases of Metabolism and Nutrition: Review of Certain Recent Contributions, *Arch. Int. Med.* **57**:422-471 (Feb.) 1936.

46. Copping, A. M., and Roscoe, M. H.: The Water-Soluble B-Vitamins in Yeast, Flour and Bread, *Biochem. J.* **31**:1879-1902 (Oct.) 1937.

47. Daniel, E. P., and Munsell, H. E.: Vitamin Content of Foods: A Summary of the Chemistry of Vitamins, Units of Measurement, Quantitative Aspects in Human Nutrition and Occurrence in Foods, Miscellaneous Publication 275, United States Department of Agriculture, June 1937.



arbitrary shares, one of which equals 10 Sherman-Chase units. For the sake of comparison these values have been converted into international units per ounce. The Daniel and Munsell publication gave figures sometimes in international units and sometimes in Sherman-Chase units per hundred grams. These have been converted into international units per ounce. There is a note in this table stating that the figure for thiamin is usually an indication of the amount of B complex present. The figures for B<sub>2</sub> from the last two sources are in Sherman-Bourquin units per ounce. There is qualitative agreement in the literature<sup>48</sup> as to the most potent sources, but the table illustrates the quantitative discrepancies so often found. These are in part due to analyses by different persons. The two figures so frequently appearing in the column based on the work of Daniel and Munsell represent the maximum and minimum in a list of observations made on different specimens at different times in different laboratories. A cipher indicates that the vitamin is absent; a dash, that no figure was given. One plus and 2 plus are qualitative indicators, meaning poor sources and fair sources, respectively.

Food	Thiamin, International Units per Ounce			Vitamin G (B <sub>2</sub> ), Sherman-Bourquin Units per Ounce	
	Addinall <sup>10b</sup>	Rose <sup>2</sup>	Daniel and Munsell <sup>47</sup>	Rose <sup>2</sup>	Daniel and Munsell <sup>47</sup>
Yeast					
Brewers', dried.....	—	709	200 to 1,180	326	500 to 1,000
Bakers', dried.....	—	142	>166	426	295 to 537
Bakers', compressed.....	—	50	—	336	—
Molasses, cane.....	210	0	0	—	—
Wheat					
Germ.....	190	170	75 to 625	86	—
Whole.....	28	21.5	28 to 113	24	16 to 33
Bran.....	56	22.5	—	+	—
Flour.....	4	0.5	—	0	—
Bread.....	3	0	—	±	—
Buckwheat.....	56	—	37	—	—
Rice					
Brown.....	28	15.5	18 to 33	0	—
Brown, boiled.....	21	—	—	—	—
Brown, polished.....	2	—	7 to 20	0	—
Rye germ.....	28	15.5	250	—	—
Corn					
Whole.....	28	+	24	+	—
Canned.....	14	—	—	+	—
Barley.....	26	—	18	—	—
Pearled.....	4	—	—	—	—
Beans					
Kidney.....	50	35	41	+	Trace
Lima.....	28	115	17 to 25	90	35
Baked navy.....	14	—	—	—	—
Soya.....	32	70	23 to 128	—	300
Peas					
Dried.....	36	85	25	100	35 to 50
Raw.....	21	42	13 to 50	28	35 to 80
Canned.....	11	+	—	8	—

(Table continued on next page)

48. H. J. Heinz Company has furnished nutritional data and charts corroborating this statement.

Food	Thiamin, International Units per Ounce			Vitamin G (B <sub>2</sub> ), Sherman-Bourquin Units per Ounce	
	Addinail <sup>10b</sup>	Rose <sup>2</sup>	Daniel and Munsell <sup>47</sup>	Rose <sup>2</sup>	Daniel and Munsell <sup>47</sup>
<b>Meats</b>					
Liver.....	46	14 (mutton)	13	258	265 to 333
Kidney.....	—	12.5	13	226	(beef) 265 to 333
		(pig)	113	—	—
Pork, lean.....	52	45	60	28	35
Ham.....	30	+ +	—	2+	—
Ham, cooked.....	—	0	—	2+	—
Bacon.....	25	+	—	24	28
<b>Beef</b>					
Muscle.....	7	+	1 to 25	23	33 to 50
Heart.....	—	—	17	—	100
Dried beef.....	14	—	25 to 33	2+	133 to 166
Mutton.....	7	17	20	2+	—
Veal.....	7	+	—	44	33 to 50
Chicken.....	7	—	—	+	—
White.....	—	21.5	50	—	—
Dark.....	—	43	100	—	—
<b>Egg, whole.....</b>					
Yolk.....	8	8	13	40	33
White.....	14	25	20 to 43	66	50 to 100
	—	0	0	25	20 to 40
<b>Nuts</b>					
Almond.....	28	11.5	27	—	—
Filbert.....	56	—	—	—	—
Hazelnut.....	56	—	66	—	—
Pecan.....	23	14	27 to 60	—	—
Walnut.....	17	42.5	50	—	—
Peanut.....	36	31	37	53	—
Peanut butter.....	—	20	—	36	—
<b>Vegetables</b>					
Asparagus.....	20	+ +	—	2+	—
Parsnip.....	20	10.5	12	—	—
Turnip greens.....	16	4.5	8	86	100
Avocado.....	—	14	17	16	18
Artichoke.....	14	+	—	—	—
Leek.....	14	—	9	—	—
Cauliflower.....	6	8	86	18	20
Cabbage.....	6	7	7 to 11	14	20
Potato.....	6	5.5	4 to 13	8	5 to 34
Potato, sweet.....	5	10	4 to 11	10	10 to 12
Carrot, raw.....	6	7	3 to 33	14	10 to 16
Carrot, boiled.....	4	—	—	—	—
Pumpkin.....	5	+	—	—	—
Broccoli.....	—	5	5 to 11	40	10 to 133
Tomato.....	—	5	3 to 13	98	4
Tomato juice.....	4	4.5	2	6	5 to 10
Lettuce.....	—	5	4 to 30	—	8 to 33
Squash.....	5	—	8	—	1
String bean.....	5	4.5	3 to 7	8	8
Spinach.....	4	11	6 to 13	6	16 to 50
Beet.....	4	1.5	—	14	16
Onion.....	4	1.5	13	4	—
Celery.....	4	+ +	Trace	—	—
Turnip.....	3.5	4.5	5 to 13	12	5 to 16
<b>Dairy products</b>					
Cow's milk.....	5	1.5	2.7 to 8	10	12 to 33
Human milk.....	3	—	1 to 7	—	6 to 11
Buttermilk.....	3	1.5	—	10	—
Cream.....	6	—	—	—	—
Butter.....	11	0	—	0	—
Cheese.....	3	+	0 to 10	14	14 to 96
<b>Fruits</b>					
Prune, dried.....	20	10	30	74	88
Apple, dried.....	9	—	—	—	—
Apple, fresh.....	3	3.5	1 to 13	6	3 to 7
Banana.....	5	15	2 to 16	10	8 to 16
Cantaloup.....	3	3	<4	—	—
Orange juice.....	5	12.5	11	10	6 to 13
Lemon juice.....	—	+	—	+	—
Peach, fresh.....	3	—	2.7	—	30
Peach, canned.....	3	—	—	—	—
<b>Sea foods</b>					
Fish.....	6	—	13	+	80
Oyster.....	11	21.5	—	2	—
Clam.....	1	—	—	0	—

Because of the yeast used in brewing I thought that beer might be an excellent source of vitamin B. Two well known breweries furnished the following figures per 12 ounce (340 Gm.) bottle:

	Vitamin B <sub>1</sub> , International Units	Vitamin G (B <sub>2</sub> ), Sherman-Bourquin Units
Company 1 <sup>49</sup> .....	35	61
Company 2 <sup>50</sup> .....	12	60

This is only 1 to 3 international units of thiamin and 5 units of vitamin G (B<sub>2</sub>) per ounce (28.3 Gm.), which could not be considered a rich source. Most of the vitamin remains in the sedimentary yeast, but that which remains in the beer is not destroyed by the pasteurization.<sup>49</sup> No figures were furnished in direct answer to a question concerning draught (unpasteurized) beer.

It will be noted that the best sources of thiamin, namely, yeast, whole grains, wheat germ, beans, peas, lean pork, liver, kidney, nuts, asparagus, parsnips, turnip greens, avocados, artichokes, egg yolk and dried prunes, are the richest also in riboflavin. Liver and kidney are especially rich in the latter while relatively poor in the former, except pig kidney, which is high in thiamin. Egg white contains no thiamin, is relatively rich in riboflavin but does not contain the P. P. (antipellagra) factor.<sup>4</sup> Fish muscle is rich in the latter but not in riboflavin.<sup>4</sup> B<sub>4</sub> is not abundant in foods and is closely associated with B<sub>1</sub>, as the latter cannot be obtained free of B<sub>4</sub> activity.<sup>4</sup> The distribution in foods of the remaining fractions of the complex is not known, but Copping and Roscoe <sup>46</sup> stated that they found all yeasts good sources of the B complex.

*Variations in the Vitamin Content of Food Stuff.*—The vitamin content of original food stuffs varies considerably with climate, soil and maturity of the plant, or diet and age of the animal. Some of the discrepancies in the table are undoubtedly due to different methods employed, and certainly some error is present from converting figures from one biologic standard to another. But study of the Daniel and Munsell report shows, for example, wide variations between different species of the same bean. The different portions of a broccoli plant had varying values, and plants grown in Arizona were especially rich. Lima beans after freezing showed only a trace of thiamin, and oysters after freezing had lost two thirds of their value. The thiamin content of milk varied with the species of cow and still more with the diet. Pasteurization lowered the content 25 per cent in some instances and left only a trace in others. The loss of vitamin B<sub>1</sub> in the storage of rice amounted to 75 per cent in four years and varied with the container, while dried and stored peas had the same vitamin G (B<sub>2</sub>) content as

49. Siemers, G. F.: Personal communication to the author.

50. Shakman, J. G.: Personal communication to the author.

fresh ones.<sup>47</sup> Another author<sup>2</sup> stated that peas in drying lose 50 per cent of their vitamin. Hanning<sup>51</sup> found peas twice as potent in 1934 as in 1932. Rose and Phipard<sup>52</sup> found peas of different seasons varying by 100 per cent. They also found that peas and lima beans lost half their B and G content by maturity. Other deleterious procedures are the treating of wines, ciders and other juices with bentonite (which absorbs vitamins B<sub>1</sub>, G [B<sub>2</sub>] and B<sub>6</sub>) and the use of alkalis, as in the curing of ripe olives and the preparation of hominy.<sup>43b</sup> The values for flour are given in the table, but it is noteworthy that patent flour contains no vitamin B.<sup>53</sup> The riboflavin in flour is reduced by storage and bleaching but not the other B vitamins.<sup>46</sup> The riboflavin content of peas and lima beans was not altered by freezing.<sup>52</sup>

*Effects of Cooking.*—The greatest loss of thiamin in cooking results from its water solubility and heat lability in neutral<sup>7a</sup> or alkaline mediums. The loss of vitamin G (B<sub>2</sub>) and the other factors is not great.<sup>2</sup> In boiling vegetables there is a great loss of thiamin if the water is discarded.<sup>54</sup> Even with the water retained Rose and Phipard<sup>55</sup> gave a loss in cooking peas of 25 per cent in fifteen minutes, beans 40 per cent and turnip greens 10 per cent. The addition of soda causes a rapid loss of B<sub>1</sub>.<sup>56</sup> The amount of exposure to the atmosphere also is important.<sup>57</sup> In acid mediums, however, thiamin is relatively heat stable<sup>7a</sup> at cooking temperatures. Apples, for instance, according to Rose have the same value raw, baked and in applesauce. Boiling of oatmeal results in a 15 per cent loss.<sup>2</sup>

In regard to losses in baking, a large exposed surface as in preparing corn flakes,<sup>2</sup> or intense heat, as in preparing griddle cakes, results in a serious loss. The moisture content is a factor, as when all moisture is removed in the baking the temperature of the food rises to that of the oven or griddle.<sup>56a</sup> Copping and Roscoe<sup>46</sup> have made extensive studies on yeast and bread. They stated that, considering the dry weight of bread, there is little variation from the original flours but that the use

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51. Hanning, F.: Vitamin B in Canned, Strained Vegetables: Further Studies, J. Am. Dietet. A. **12**:231-236 (Sept.) 1936.

52. Rose, M. S., and Phipard, E. H. F.: Vitamin B and G Values of Peas and Lima Beans Under Various Conditions, J. Nutrition **14**:55-67 (July) 1937.

53. Copping and Roscoe.<sup>46</sup> Daniel and Munsell.<sup>47</sup>

54. Rose.<sup>2</sup> Garnett, W. P.: Personal communication to the author. Smith.<sup>43b</sup> Other writers, too numerous to cite.

55. Rose.<sup>2</sup> Rose and Phipard.<sup>52</sup>

56. (a) Itter, S.: Personal communication to the author. (b) How We Get Our Vitamins, Special Circular, Extension Service, Department of Agriculture. University of Wisconsin, June 1936. (c) Other writers, too numerous to cite.

57. Jones, D. B.: Personal communication to the author.

of baking powder completely destroys the vitamin B<sub>1</sub>. Others gave a loss of 10 per cent to 25 per cent in baking bread.<sup>43b</sup> The amount of yeast involved does not alter the vitamin content.<sup>46</sup> The quantity of vitamin B<sub>1</sub> in whole wheat bread (300 international units per pound [0.45 Kg.]) is three times that in white bread, but the amounts of riboflavin and of the vitamin G (B<sub>2</sub>) complex are more nearly the same for the two kinds of bread. Processing bran for breakfast food results in a 50 per cent loss.<sup>2</sup> One biscuit company reported a high figure for graham crackers but stated that this is variable owing to changes in the  $p_H$  of the dough.<sup>58</sup>

The Department of Agriculture<sup>57</sup> reported that commercial canning by modern methods results in much less loss than cooking in open containers. One canning company<sup>59</sup> stated that the whole process of cooking, canning and sterilizing may result in a loss of one-third the original B<sub>1</sub> content but that there is only negligible loss of the other B factors. Their published tables contain only qualitative information. Hanning<sup>51</sup> gave the results of her analysis of B<sub>1</sub> content of canned vegetables in international units per ounce (28.3 Gm.), which compare with the values for raw foods in the earlier tables as follows:

Tomatoes.....	7 to 12	= No change
Peas.....	8.2	= 60% to 84% loss
Carrots.....	3.0	= 50% loss
Green beans.....	1.0	= 60% to 80% loss
Beets.....	1.0	= 33% to 75% loss
Spinach.....	1.6	= 60% to 88% loss

Another canning company<sup>60</sup> showed variable results in their published analyses. Tomatoes have about the value of the raw vegetable, while a compound of whole milk, whole wheat with added wheat germ and soybeans, which should certainly show a high B<sub>1</sub> content, has a value of only about that of raw milk.

From these facts it becomes evident that, even with the aid of Cowgill's formula or an assumed arbitrary standard of adequacy, dietary histories recorded by Watson's chart or dietary diaries kept by the patient are rendered almost worthless in the estimation of the intake (not to mention absorption) of vitamin B by the variability of the content of the original food stuffs and the losses through storing, processing and cooking. Even with weighed diets of known caloric value, the problem becomes one to tax the guessing ability of a trained dietary expert and is far beyond the otologist in actual office practice. The clinical laboratory does not help, and the alleged clinical manifestations of mild deficiency of vitamin B are protean and vague. Therapeusis

58. Lankenau, J. C.: Personal communication to the author.

59. Harding, E. R.: Personal communication to the author.

60. Libby, McNeil & Libby.

must be based for the present on an assumption made by the practitioner of the art of medicine rather than on a diagnosis substantiated by scientific means.

NOTE.—Since this was written Selfridge<sup>61</sup> has shown that the greater part of the improvement in hearing is due to nicotinic acid, while only a small fraction of the benefit is derived from thiamin.

#### REPORT OF CASES

The following epitomized case histories present the author's somewhat inconclusive experience with vitamin B treatment for impaired hearing:

CASE 1.—Mrs. S. A. W., aged 77, reported for treatment on June 17, 1938, complaining of loss of hearing for eighteen months, with roaring tinnitus. Tuning fork tests of the right ear showed impaired hearing throughout the scale, more marked in the lower portion, with shortened bone conduction and a raised low tone limit. In the left ear there was impairment throughout the scale, more marked for upper tones, with a lowering of the high tone limit. The eustachian tubes were normal on both sides. A diagnosis of mixed deafness was made and vitamin B complex made from rice bran prescribed, the daily dose being about 1,000 international units of vitamin B<sub>1</sub> and 200 Sherman-Bourquin units of vitamin G (B<sub>2</sub>), the other factors being present in the same proportions as found in the natural bran. At the end of three months the bone conduction in the right ear had increased from ten seconds to fifteen seconds (normal) for the C-2 fork. The C-4 fork was not as well perceived, but the hearing for the C-5 fork was slightly improved. In the left ear the bone conduction was increased from eight to thirteen seconds, the perception of the C-4 fork from ten to thirteen seconds and that of the C-5 fork from three to five seconds. Measured by the Galton whistle, the high tone limit in the left ear, which had been 20,000, improved to 25,000. The patient's family had noted the improvement in hearing.

CASE 2.—Mrs. M. M. S., aged 65, was first examined on Sept. 14, 1937, stating that she had lost the hearing entirely in the left ear at the age of 12. There had been no suppuration, mumps, poliomyelitis or other ascertainable cause. The hearing in the right ear also was somewhat impaired and had become worse at the time of the climacteric. The patient did not know if the symptoms had been aggravated by pregnancies. She had two brothers and a sister deaf in the left ear. There was no deafness on the maternal side. The father was somewhat deaf, the condition coming on at about 70 years of age. The paternal grandfather was deaf. Bárány masking of the right ear showed total deafness of the left ear. Tuning forks demonstrated moderate impairment of hearing in the right ear throughout the scale, with slightly shortened bone conduction. The eustachian tubes were somewhat stuffy, the patient recently having had a cold. After a few inflations they opened well and stayed open. Vitamin B complex made from rice bran was prescribed, and after three months the results of testing were about

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61. Selfridge, G.: The Eighth Nerve in Relation to Thiamin Chloride and Nicotinic Acid: A Comparative Study, *Ann. Otol., Rhin. & Laryng.* **48**:419-432 (June) 1939.

the same, with the exception that the C-4 fork was heard for fifteen seconds instead of ten seconds. The patient thought there was a slight improvement. There was no change in the totally deaf ear.

CASE 3.—Dr. D. B. W., aged 42, first noticed slight high-pitched tinnitus in both ears at the age of 38, with slight difficulty in hearing, especially in crowds. The patient had had considerable urticaria and hyperesthetic rhinitis, but there had been no allergic manifestations for several years. There was a questionable history of healed pulmonary tuberculosis. There were no foci of infection. Repeated audiograms over four years had shown a practically stationary loss, beginning at C-5 and increased at C-6. After he had taken vitamin B complex for three months in amounts similar to those prescribed in case 1, the right ear showed a further loss of 10 per cent for the frequency 4096, while the left ear showed an improvement of 15 per cent throughout the lower portions of the scale. At 4096 the hearing was unchanged, while at 8192 there had been an improvement from 70 to 85 per cent. The tinnitus was somewhat less marked.

CASE 4.—Mr. C. H. K., aged 38, was first seen on Jan. 20, 1938, when he stated that the hearing in the right ear had been somewhat less acute than that in the left ear for several years, becoming somewhat more impaired three years before. There was no tinnitus, nor had there ever been any suppuration. One brother was not deaf, but the mother had begun to lose her hearing before she was 40 years of age and had to use an artificial aid. The father was not deaf. The hearing of other relatives was unknown. There was no sinusitis. The tonsils were out and the teeth sound, and there were no symptoms referable to the general health. Hearing was impaired at both ends of the scale, with increased bone conduction. The eustachian tubes were entirely normal. A diagnosis of otosclerosis was made. The patient had a series of twelve injections of vitamin B<sub>1</sub>, receiving 6.66 mg. of synthetic thiamin (2,000 international units) daily, and thereafter took vitamin B complex by mouth for two months, receiving a daily dose similar to that given in case 1. At the end of two months there was no change whatever in the the hearing.

CASE 5.—Miss B. D. X. had been coming to my office for treatment for many years. In 1922 she had had encephalitis and had not been in robust health since that time. In 1929, at the age of 42, an artificial menopause was produced by roentgen rays. Subsequent to this transient attacks of light headedness developed, which eventually became attacks of actual loss of consciousness, in one of which she fell and injured herself. Deafness was first noticed in 1934, at which time a moderate impairment of perception for low tones was noted, with increased bone conduction. She had recurrent attacks of nasal allergy, during which the eustachian tubes closed. They were always restored to normal by inflations with a catheter and remained so between allergic attacks. The following year attacks of vertigo developed, precipitated by sudden movement and sometimes lasting several hours. Thorough examination for foci of infection revealed none. Fractional cold caloric tests elicited normal responses. There was no evidence of nerve deafness at that time. The attacks eventually subsided under treatment with large doses of ammonium chloride and have not recurred. The patient had been showing progressive shortening of bone conduction on the left side, and in January 1937, at the age of 50, she had a slight loss of perception of C-5 in the right ear and slightly shortened bone conduction in the left ear, with impairment of hearing for C-4 and C-5. The tone limits were normal. At that time there was no catarrh of the eustachian tube. Vitamin B<sub>1</sub> was prescribed, 2,000 units to be administered paren-

terally daily for one month, after which vitamin B complex was given by mouth in doses similar to those in case 1 for three months, at the end of which time hearing tests showed no change whatever.

CASE 6.—Miss B. T., aged 51, had had progressive deafness all her life, which had at first been diagnosed as conductive, but later was thought by two different otologists to be otosclerotic. She had been using an artificial aid for several years. Unfortunately, there was no more recent record of her hearing than two years prior to her taking large doses of vitamin B complex over a period of three months. However, at the end of that time hearing tests, compared with those of two years before, showed further slight impairment of hearing for C-2 by air and bone conduction, while perception of C-4 was slightly improved in both ears and that of C-5 unchanged.

CASE 7.—Mr. A. H. M., aged 65, was seen in February 1938, complaining of buzzing and deafness in the left ear for ten days, which he attributed to an occasional explosive sound over the telephone. There was moderate impairment at both ends of the scale, but in the Weber test the sound was referred to the good ear and the bone conduction markedly shortened in the worse ear, leading to a diagnosis of nerve deafness. The eustachian tubes were normal, and there were no foci of infection. After administration of vitamin B complex by mouth as in the previous cases for these months, hearing tests showed no change whatever. Twenty-five days later splenectomy was performed for idiopathic thrombopenic hemorrhagic purpura, and the patient did not recover. The systemic disorder might, of course, have been a factor in the nerve deafness of apparently acute onset.

Similar treatment has been prescribed in other cases, but it has been impossible to obtain follow-up reports because the patients live at a distance.

#### SUMMARY

The indexed literature of vitamin B has been reviewed up to January 1938, embracing a discussion of the chemical nature and physiologic effects of the various fractions, the clinical symptoms of deficiency of vitamin B, the various units employed, the natural sources and the human requirements.

It has been impossible to formulate a definite clinical syndrome for mild B deficiency.

A review of laboratory procedures failed to disclose one applicable to ordinary clinical practice.

Variations in the content of foods due to various factors render an estimation of the intake in the diet extremely inaccurate.

A review of my cases of deafness treated by vitamin B suggests that there is a possibility of helping some persons by this means but that at the present time there are no means of selecting the patients who may be improved.

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# RECONSTRUCTION AFTER RADICAL OPERATION FOR OSTEOMYELITIS OF THE FRONTAL BONE

EXPERIENCE IN EIGHTEEN CASES

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Since 1931, at the suggestion of Dr. H. P. Mosher, a radical operation for osteomyelitis of the frontal bone has been used routinely at the Massachusetts Eye and Ear Infirmary. Because of the poor prognosis with conservative treatment, radical resection of the frontal bone has been adopted as the operation of choice at other hospitals as well.

The adoption of this radical operation has greatly diminished the mortality from the disease. For instance, statistics show in 1928 and 1930 a total of 6 cases, with a mortality of 83.3 per cent—only 1 patient out of 6 surviving; during the years 1936, 1937 and 1938,<sup>1</sup> 8 patients were treated without a mortality.

The new operation, however, has created another problem, namely that of the deformity. It is unnecessary to enlarge on its psychologic, social and economic consequences for the patient.

Eighteen patients have been referred to the plastic service of the Massachusetts Eye and Ear Infirmary for repair of the deformity. Eleven patients were from the clinic; 7 were private patients. Eleven were males; 7 were females. The ages ranged between 8 and 44 years. Fourteen patients, or approximately 75 per cent, were under the age of 25. Eleven patients, or approximately 60 per cent, were under the age of 21.

Just as is radical resection of the frontal bone, plastic repair of the consequent deformity is now a standardized procedure at the Massachusetts Eye and Ear Infirmary.

Being concerned in this paper essentially with the plastic repair, we do not wish to discuss osteomyelitis of the frontal bone. On that

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From the plastic clinic of the Massachusetts General Hospital and the Massachusetts Eye and Ear Infirmary.

Read before the Section on Laryngology, Otology and Rhinology at the Ninetieth Annual Session of the American Medical Association, St. Louis, May 18, 1939.

1. Until Sept. 1, 1938.

subject we refer the reader to other publications.<sup>2</sup> Ten of the cases in this series have been reported in two previous papers, by Drs. Mosher and Judd<sup>3</sup> and by Dr. Mosher.<sup>4</sup>

#### OPERATION FOR OSTEOMYELITIS

Briefly summarized, the manner of treating osteomyelitis of the frontal bone in this hospital is as follows: The object of the operation being the complete eradication of the diseased focus and the prevention of recurrence, the frontal bone, after incision of the skin and periosteum and exposure, is removed en masse with the Hudson drill. Trephine holes are made in healthy bone away from the diseased area, and are joined with the Gigli saw (fig. 1 *A*). The anterior and posterior walls of the frontal sinuses are removed with rongeurs. After the operation there is a large defect in the bone in the frontal area, limited by the edges of the surrounding bone, and an area of dura of corresponding size is exposed. The wound is carefully packed so that the skin flaps, along with the periosteum, are kept elevated and turned away from the edges of the defect in the bone to permit their regular inspection for recurrence or formation of sequestrums (fig. 1 *B*). Until these possibilities are eliminated, along with that of intracranial complications, there is no question of plastic closure.

#### PROBLEM OF PLASTIC CLOSURE

The patient presents himself with a large gaping wound in the forehead (fig. 2). A large area of dura lies uncovered and unprotected by bone. The problem from a plastic point of view is twofold: first, that of closing the defect in the soft tissue by an approximation in proper position of the skin flaps; second, that of replacing the absent bone.

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2. (a) Furstenberg, A. C.: Osteomyelitis of the Skull: The Osteogenetic Processes in the Repair of Cranial Defects, *Ann. Otol., Rhin. & Laryng.* **40**:996 (Dec.) 1931; The Pathology of the Spread of Osteomyelitis of the Skull: Its Relation to Brain Abscess, *Tr. Am. Laryng., Rhin. & Otol. Soc.* **39**:423, 1933. (b) Adson, A. W.: Surgical Treatment of Osteomyelitis of the Skull, *Proc. Staff Meet., Mayo Clin.* **8**:169 (March 15) 1933. (c) Behrens, H. C.: Osteomyelitis of the Skull of Otitic and Paranasal Sinus Origin, *Arch. Otolaryng.* **25**:272 (March) 1937. (d) Adson, A. W., and Hempstead, B. E.: Osteomyelitis of the Frontal Bone Resulting from Extension of Suppuration of the Frontal Sinus: Surgical Treatment, *ibid.* **25**:363 (April) 1937.

3. Mosher, H. P., and Judd, D. K.: An Analysis of Seven Cases of Osteomyelitis of the Frontal Bone Complicating Frontal Sinusitis, *Laryngoscope* **43**:153 (March) 1933.

4. Mosher, H. P.: Osteomyelitis of the Frontal Bone: Notes on Three Cases, *J. A. M. A.* **107**:942 (Sept. 19) 1936.

## TYPE OF INCISION

The type of incision which is made at the time of the initial operation for the removal of the osteomyelitic frontal bone necessarily has a bearing on the secondary plastic operation. The primary object of the cutaneous incision is the proper exposure of the frontal bone. How-

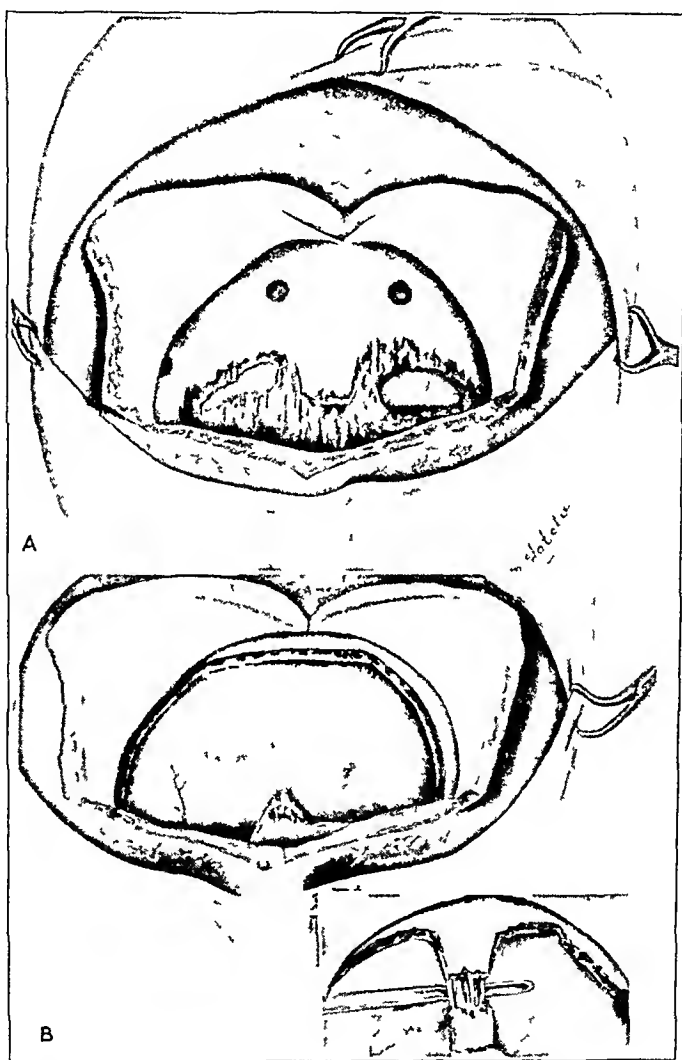


Fig. 1.—*A*, diseased bone exposed and drill holes made at a distance from the osteomyelitis. *B*, frontal bone resected; a portion of the anterior wall of the left frontal sinus still remaining, to be removed along with the posterior wall.

ever, in the process of repair objections were found to certain types of incision. Modifications of the incisions were proposed, which did not handicap the operator but greatly facilitated subsequent repair. As much as possible, an effort has been made to bear this consideration in mind and to use the most favorable type of incision.

The inverted U incision (fig. 3 *A*), ideal cosmetically, because sparing an incision through the lower part of the forehead and the eyebrows, proved to give insufficient exposure of the lower portion of the frontal bone and the frontal sinuses and to be unfavorable to surgical drainage.

The straight U incision (fig. 3 *B*) was attended with considerable difficulty in keeping the flap elevated and sufficiently retracted to afford an inspection of the upper edge of the defect in the frontal bone, its natural tendency being to fall down over the wound. In the course of the plastic repair difficulties were encountered in dissecting away from the dura and in bringing down the curled-up flap. From a plastic point

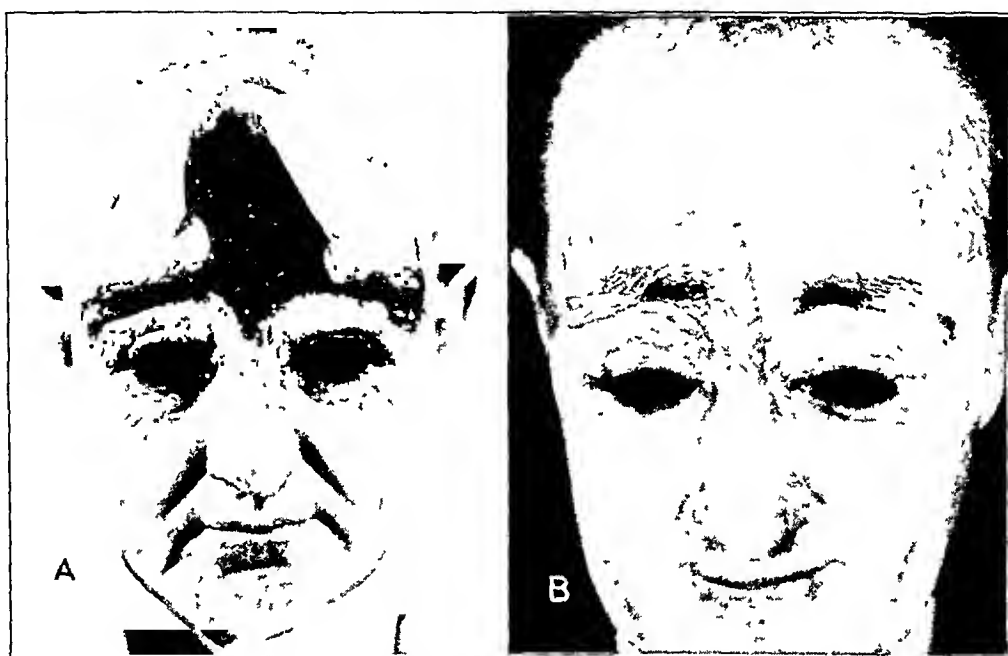


Fig. 2.—*A*, patient with large, gaping wound in the forehead, following the removal of a large section of the frontal bone. *B*, patient after closure of the wound, fourteen days after operation.

of view the straight U incision appeared to present only disadvantages over the inverted T incision.

The latter consists of a vertical branch extending upward in the midline of the forehead, above the area of osteomyelitis indicated by the edema, usually above the hairline, and a horizontal branch passing through, above or below the eyebrows.

At first the horizontal incision was passed through the eyebrows (fig. 3 *C*), with the idea of dissimulating part of the scar. It was found that when the skin flaps were brought together the eyebrows were considerably distorted, because one half was carried up with the reflected skin flap while the other half remained in its proper position. When the

reflected flap was secondarily brought back into position, the eyebrows could not always be exactly fitted. Often a wide hairless scar separated the upper from the lower half of the eyebrows. This distortion was marked enough to necessitate special subsequent operative correction.

It was therefore decided to avoid incision through the eyebrows and to adopt an incision either above or below them.

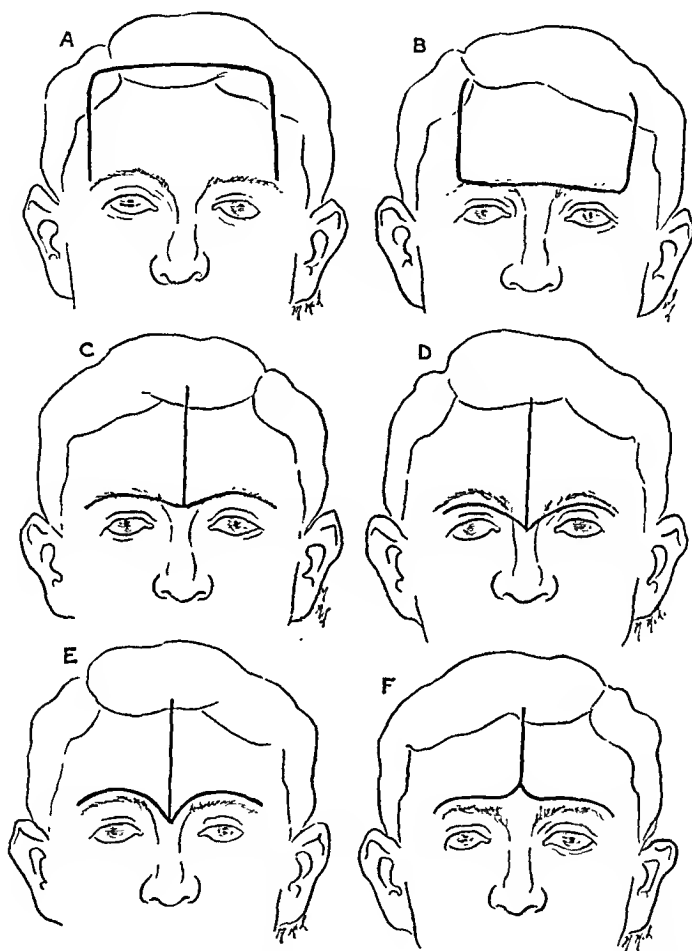


Fig. 3.—*A*, inverted U incision. *B*, straight U incision. *C*, inverted T incision passing through the eyebrows. *D*, inverted T incision below the eyebrows. *E*, inverted T incision carried just above the eyebrows. *F*, inverted T incision above the eyebrows, with rounded angles, the most desirable type of incision for exposure of the frontal bone.

The incision below the eyebrows (fig. 3 *D*), while giving a slightly better exposure of the front face and floor of the frontal sinuses, presented the disadvantage over the incision above them that they were completely carried away from their normal position by the skin flaps.

The incision carried just above the hairline of the eyebrows appeared, therefore, the most favorable (fig. 3 *E*).

It was noticed, however, that at the point of junction between the horizontal and vertical branches localized sloughing occurred rather frequently when the flaps were sutured together, apparently because this is a meeting point of angles of tissues of diminished blood supply. It was found advisable to round off the angles. The most suitable incision has appeared to be that illustrated in figure 3 *F*.

#### POSTOPERATIVE CARE AND PERIOD OF OBSERVATION

When one has performed the resection of the frontal bone, using the most favorable cutaneous incision, the question arises as to how soon the first stage of plastic repair, or closure of the soft tissues, may be performed. After the radical removal of the frontal bone, the wound is kept clean with sterile solution; if secondary infection of the wound

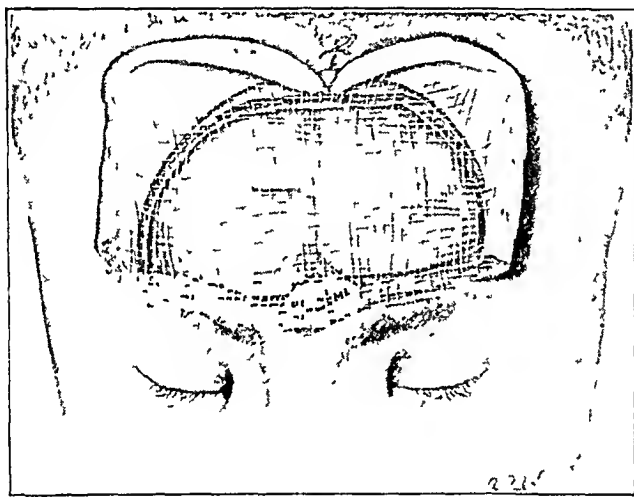


Fig. 4.—Coarse paraffin mesh protecting the dura from the dressing in the early stages.

should set in antiseptics such as dilute solution of sodium hypochlorite may be used; bacteriophagic dressings and urea solution have occasionally been used. A nonadherent perforated tissue, such as "silkaloid," protects the dura from the dressing in the early stages (fig. 4). During this period attention is focused on watching the edges of the defect in the bone for recurrence of the osteomyelitis and for sequestrums by stripping back the flaps along with the periosteum and on detecting possible intracranial complications.

Experience gained in this series of eighteen cases has shown that the plastic closure should not be performed until all suppuration has ceased and the wound has become filled with healthy granulations. An excellent index of the time to operate is the presence of a thin layer of newly formed epithelium covering most of these granulations. This process usually takes two to three months. If the wound is closed at

an earlier period it appears impossible to be sure that all suppuration has ceased. Pus may be pocketed off in small areas under one or both flaps. In 1 case, closure was performed forty-two days after the removal of the frontal bone; an abscess of the brain developed, which was found two months later and drained. The patient subsequently died of meningitis; although this result cannot be attributed directly to the plastic closure, the fact remains that closure was performed too early.

It was noticed also that in practically all the cases definite marginal sequestration of bone occurred from thirty to sixty days after the operation. In 1 of the cases, after repeated cultures showing absence of active infection, closure of the wound was performed, fifty-two days after the operation. There followed troublesome months, during which subcutaneous abscesses were incised and sequestrums were removed.

In conclusion, therefore, it appears that haste should not be taken in performing the plastic closure after the resection of the frontal bone for osteomyelitis. Delay of at least three months is advisable.

#### FIRST STAGE OF PLASTIC REPAIR

The first stage of the plastic repair, closure of the defect in the soft tissue, consists in bringing down the skin flaps from their position curled up over the edges of the bone to their original site.

The operation has been performed both under a general anesthetic, usually ether, and under local anesthesia induced by infiltration of a 2 per cent solution of procaine hydrochloride with a 1:50,000 solution of epinephrine; it is carried out in the following successive stages:

1. The skin flaps are dissected away from the dura and the surrounding bone (fig. 5 *A* and *B*). The flaps are found curled up, apparently because of the pull of the fibroblasts and elastic fibers of the subepithelial tissue.

2. The thin layer of new epithelium is shaved off with a knife (fig. 5 *C*).

3. To break the pull of the deep layer and to permit liberation of the flap a series of crisscross incisions is made with the knife through the subepithelial tissue (fig. 5 *D*).

4. The flaps are then drawn down into their original position and sutured with the finest silk sutures after careful trimming of the edges of the skin to insure perfect approximation (fig. 5 *E*).

Careful hemostasis is essential. Finally a mildly compressive dressing is applied. It is not unusual to meet small pus pockets or necrotic bone in the process of dissecting the flaps. Careful placing of rubber drains and the removal of the necrotic bone usually prevent complications in such cases.

After this plastic closure the appearance of the patient is considerably improved (fig. 2*B*). Instead of an ugly, irregular wound, there is a smooth forehead with a continuous covering of skin. There is still, however, noticeable deformity due to the absence of bone. From the front of the face, a depression can be seen. Under the skin, pulsations of the brain can be perceived, which are distinctly felt by the patient. In profile, flattening of the frontal region gives the patient a

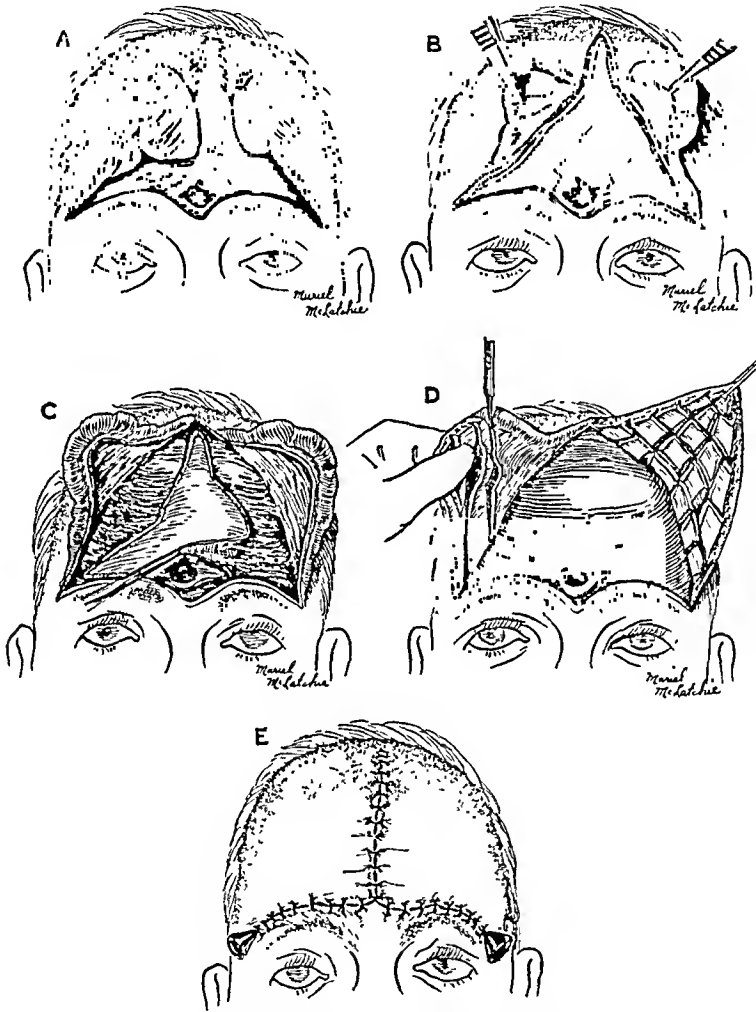


Fig. 5.—*A*, wound of three months after resection of the frontal bone. *B*, skin flaps dissected back, exposing the surrounding bone; superficial epithelium incised. *C*, epithelium dissected over the layer of granulations covering the dura. *D*, incisions carried through subepithelial tissue to permit extension of the skin flaps. *E*, skin flaps sutured into position, with drains in place.

peculiar appearance, "birdlike" in extreme examples (fig. 6). Moreover, the patient is usually worried about the presence of the frontal lobes under the skin. He becomes haunted by the thought of possible injury and in most cases wears a protective headpiece over the defect in the bone.



The extent of the deformity is naturally directly related to the amount of frontal bone removed and to the height of the forehead. In a patient with a low forehead the deformity is not as noticeable, since the hair compensates greatly for the lack of fulness of the frontal region.

The defect in the frontal bone is irregularly quadrilateral and varies from 7 to 12 cm. in width and from 6 to 10 cm. in height. It is evident, therefore, that a second stage in plastic reconstruction is indicated, to replace the lost bone.

#### REGENERATION OF BONE

The question arises at this point how much regeneration of bone one can expect and how long one should wait for it to occur.



Fig. 6.—Extreme flatness of the forehead.

A revision of the roentgenograms made in the cases of this series was done by Dr. A. S. MacMillan. It appeared that there was regeneration of bone in 2 cases. The regeneration was complete and was observed about eighteen months after the removal of the frontal bone. Both patients were children, aged 8 and 9 years respectively (fig. 7). In none of the 16 other cases was any definite regeneration observed. The youngest patient in these 16 cases was 13. Roentgenograms were taken periodically in all the cases; some patients were followed for six years after the removal of the frontal bone.

Why should there have been regeneration in the cases of the 2 children and none in the other cases? According to Gray the skull grows rapidly from birth to the seventh year, by which time the foramen magnum and the petrous parts of the skull have attained their full size. Around puberty a second period of activity occurs; this results in an increase in all directions, but it is especially marked in the

frontal and facial regions, where it is associated with the development of the sinuses.

That bony regeneration is remarkably active in children is confirmed by the complete obliteration of the frontal defect in the 2 children. In another case, not included in this series, that of a boy aged 8 years, in which conservative treatment was used on account of the widespread extension of the osteomyelitis throughout the skull, regeneration of nearly the whole calvarium was observed.

In the other 16 cases of this series no regeneration of bone was found. This observation is generally confirmed by a review of the literature on the subject, and the accepted opinion that the flat bones of the skull do not regenerate appears to be substantiated.

That there are exceptions is evident. Furstenberg<sup>2a</sup> cited numerous examples and gave a whole series of cases in which bone was regener-

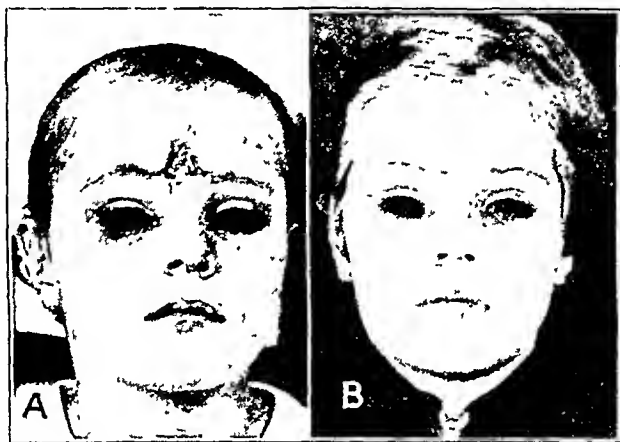


Fig. 7.—*A*, patient before plastic repair. *B*, patient after plastic closure and spontaneous regeneration of bone.

ated. If there is regeneration in certain cases and not in others, what is the determining factor?

If the periosteum is responsible for regeneration of bone it is given a poor chance to survive. After the resection of the frontal bone the skin flaps and the periosteum are reflected back to expose the edges of the remaining bone. Rapidly the natural tendency of the periosteum and of the subcutaneous tissue to shrink causes the skin flap to curl on itself. The periosteum tends to disappear under the flap and ceases to remain a distinct structure, lost as it is in an amalgam of newly formed granulations. Therefore, when the plastic closure is done and the skin flaps are brought down into their former position, the periosteum has ceased to exist as such and the periosteum of the surrounding bone is probably incapable of producing new bone, because for regular inspection of the edges of the bony defect it must be stripped up from the bone and this maneuver repeated regularly may produce an area

of devitalized bone, lacking a normal periosteum, which encourages sequestration, and inhibits bony regeneration.

If this procedure, however, were not carried out in the early stages and the wound were allowed to close it would be impossible to watch for progression or recurrence of the osteomyelitic process except by roentgen examination, which often reveals the presence of osteomyelitis only as late as ten days after the direct inspection of the bone would have revealed it (Mosher).

To explain regeneration of bone, Furstenberg expressed the opinion that the dura and even the adjacent connective tissue may become osteogenic. In 2 recent cases, not included in this series, triangular flaps of normal periosteum were brought down from the upper frontal region to lie over the bony defect prior to suturing the skin flaps. In bringing down this periosteum it was turned over on itself, the side toward the normal bone above becoming the outer side. Regeneration has not occurred in these 2 cases after five months and after three months.

Judging from the experience gained in this series, it appears that it is impossible to rely on spontaneous regeneration of bone and that the bone must be replaced by operative measures. The second stage of the plastic reconstruction for the closure of the defect in the frontal bone will now be considered.

#### SECOND STAGE OF PLASTIC REPAIR

Since the World War numerous reports have been made of methods for replacing loss of bone in defects of the skull. A review of the literature showed that most of the methods proposed for the closure of such defects apply to much smaller ones than those following resection of the frontal bone. Most of the defects followed operative trephining or shrapnel or bullet wounds. For these the use of an osteoperiosteal graft removed from the outer table of the skull, as proposed by Mauclore,<sup>5</sup> Müller and Koenig,<sup>5</sup> Jones,<sup>6</sup> Reed,<sup>7</sup> Frazier and Ingham,<sup>8</sup> Coleman<sup>9</sup> and Gurdjian,<sup>10</sup> appears ideal. For larger defects,

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5. Cited by Juvara, E.: *Procédé de cranioplastie: Reconstitution de la paroi crânienne par des greffes, minces lames osseuses découpées à la scie de la corticale interne du tibia*, *Rev. de chir.*, Paris **52**:401 (June) 1933.

6. Jones, R. W.: *Repair of Skull Defects by New Pedicle Bone-Graft Operation*, *Brit. M. J.* **1**:780 (May 6) 1933.

7. Reed, J. V.: *Repair of Cranial Defects*, *Am. J. Surg.* **18**:285 (Nov.) 1932.

8. Frazier, C. H., and Ingham, S. D.: *Review of the Effects of Gunshot Wounds of the Head Based on the Observation of Two Hundred Cases at U. S. General Hospital No. 11, Cape May, N. J.*, *Arch. Neurol. & Psychiat.* **3**:17 (Jan.) 1920.

various methods have been proposed. Plates made of silver or <sup>11</sup> celluloid <sup>12</sup> have been universally recognized as unsuccessful. Boiled bone <sup>13</sup> and bone removed from cadavers have been used. Naffziger <sup>14</sup> gave an account of the use of pathologic bone removed from the skull, sterilized and transplanted back to its former site with success. Gurdjian <sup>10</sup> used boiled bone removed from the skull of a cadaver after sterilizing it and observed its resorption within eighteen months. Pankratiev <sup>15</sup> described 4 successful transplants of sterilized bone from cadavers.

O'Connor <sup>16</sup> used large grafts of beef cartilage supplemented by small cartilaginous isographs to fill in frontal defects.

Cartilage removed from the ribs was used extensively during the war, particularly by Morestin.<sup>17</sup> While an excellent transplant material, cartilage has the inconvenience of having to be used in multiple pieces, as a single piece large enough cannot be obtained; moreover, it affords little protection, as it merely becomes encapsulated in fibrous tissue without cementing itself to the adjacent bone.<sup>18</sup> It was used extensively in some of the cases reported in this paper to fill in certain minor defects following the closure of the defect by the bone graft.

Osteoperiosteal grafts appear to be most practical, because they are easy to obtain and become joined to the adjacent bone to form a continuous protective bony covering. Grafts have been obtained from the scapula,<sup>19</sup> the ribs and the ileum, but the most satisfactory source is the tibia. Easily accessible, the tibia yields the large flat grafts that are needed to repair large defects.

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9. Coleman, C. C.: Repair of Cranial Defects by Autogenous Cranial Transplants, *Surg., Gynec. & Obst.* **31**:40 (July) 1920.

10. Gurdjian, E. S.: Management of Depressed Fractures of the Skull and Old Skull Defects, *Ann. Surg.* **102**:89 (July) 1935.

11. Elsberg, C.: Plate for Defects of the Skull, *Ann. Surg.* **47**:795, 1908.

12. Mitchell, A. B.: Repair of Injuries to the Skull by Perforated Plates, *Brit. J. Surg.* **5**:40 (July) 1917.

13. Babcock, W. W.: Soup Bone Implant for the Correction of Defects of the Skull and Face, *J. A. M. A.* **69**:352 (Aug. 4) 1917.

14. Naffziger, H. C.: Restoration of Defects in the Skull, with Special Reference to the Management of Intrinsic Tumors of the Skull and Certain Types of Localized Osteomyelitis, *Ann. Surg.* **104**:321 (Sept.) 1936.

15. Pankratiev, B. E.: Deaf Bone Grafts to Repair Skull Defects, *Ann. Surg.* **97**:321 (March) 1933.

16. O'Connor, G. B.: Contour Reconstruction After External Frontal Sinus Operation, *Ann. Otol., Rhin. & Laryng.* **47**:138 (March) 1938.

17. Morestin, cited by Woodroffe, H. L. W.: The Reparation of Cranial Defects by Means of Cartilaginous Grafts, *Brit. J. Surg.* **5**:42 (July) 1917.

18. Primrose, A.: Cranioplasty: The Value of a Graft of Bone, Cartilage or Fascia in Closure of Cranial Defects Caused by Wounds of War, *Ann. Surg.* **70**:1 (July) 1919.

19. Jones, B. L.: Bone Transplantation from Scapula, *Ann. Surg.* **66**:160 (Aug.) 1917.

Delangenière<sup>20</sup> reported 104 cases of successful transplantation by this method. He put the periosteal surface against the dura. If necessary he used two layers of graft with the rough bony surfaces facing each other.

Albee,<sup>5</sup> to obtain the necessary curvature of the graft, made a series of parallel lines on its under surface with the electric saw, rendering it possible to bend it to the desired shape.

Juvara<sup>21</sup> laid the graft over the dura, its internal or rough surface inward, having previously smoothed it with a large file. He used a special forceps to bend the graft to the suitable shape.

Similar methods, slightly modified, were reported by Tillier,<sup>22</sup> Brenizer<sup>23</sup> and Rhodes.<sup>24</sup>

In this group of 18 cases, bone grafting was carried out in 4. In 2 cases of children, the patient presented complete regeneration. In the other 12, either the patient did not care to undergo an additional operation, or sufficient time has not elapsed at the time of writing for the operation to be performed.

In all the cases sufficient time was allowed to permit bony regeneration, the period between the closure of the soft tissues (first stage) and the bone grafting (second stage) having been from twelve to eighteen months.

The operation for transplanting bone to the frontal defect has been performed under general anesthesia, under local anesthesia, and under a combination of both methods (avertin with amylene hydrate and a local anesthetic).

1. Incisions are made through the scars in the frontal area, and the flaps are dissected away from the dura until the edges of the surrounding bone are encountered.

2. The periosteum covering the surrounding bone is elevated over about 2 cm., and the bony edges are freshened with a rongeur.

3. Careful hemostasis of the wound is then carried out.

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20. Delangenière, H., and Lewin, P.: A General Method of Repairing Loss of Bony Substance and of Reconstructing Bones by Osteoperiosteal Grafts Taken from the Tibia, *Surg., Gynec. & Obst.* **30**:441 (May) 1920.

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22. Tillier, R.: Cranioplasty for Large Loss of Frontal Bone, *Bull. et mém. Soc. nat. de chir.* **56**:1277 (Nov. 29) 1930.

23. Brenizer, A. G.: Total Bone Grafts into Skull Defects, *Ann. Surg.* **64**:516 (Nov.) 1916.

24. Rhodes, R. L.: Treatment of Cranial Defects by Bone Grafting, *Surg., Gynec. & Obst.* **19**:546, 1914.

4. An incision is made medially to the crest of the tibia, exposing its inner aspect. The length of the incision is determined by the length of the graft to be removed and is generally from 10 to 15 cm. After a good exposure of the bone covered by its periosteum a wide, flat and rather thick (about 0.5 cm.) osteoperiosteal graft is removed with a wide chisel. In certain cases one wide graft is sufficient, but generally two grafts are necessary.

5. Each graft is grasped between compresses and fractured into the proper curvature to reproduce the natural contour of the forehead.

6. The grafts are then introduced, one in the lower and the other in the upper portion of the defect. They are placed with the periosteal surface outward, the ends in contact with the edges of the surrounding bone; the periosteum of the graft is sutured to the periosteum of the adjacent bone.

7. The skin flaps are sutured together with fine silk, and a mildly compressive and immobilizing dressing is applied.

A systematic check-up by roentgenograms, carried out over years at the Massachusetts Eye and Ear Infirmary, has shown that the grafts have been successful.

The appearance of the patient approaches that of a normal person. The contour of the forehead is satisfactory, and the grafts are firm, solid and resistant (fig. 8).

The reasons for not transplanting bone at the initial operation are as follows:

1. The occurrence of intracranial complications cannot be excluded even at this stage; therefore, it is felt that it is safer to repair the cutaneous defect first.

2. As most of the patients have large frontal defects, the operative trauma is considerable. Moreover, because of the possibility of infection, it is advisable to take no chances of failure of the bone graft. With small defects, when the entire wound is covered by epithelium, it may be safe to transplant bone at the initial operation for the repair of the defect. This was successfully done in 2 cases.

3. Usually an opening at the nasofrontal duct communicating with the nasal cavity is present at the first operation.

Transplantation of bone improves the appearance of the patient and contributes added protection. However, it was found that in order to gain further cosmetic improvement in some cases it has been necessary to add pieces of cartilage over the eyebrows and frontal eminence. In 1 case a large piece of dermal graft was inserted over the entire

forehead four months after the operation for bone graft, with a rather pleasing effect on the contour of the forehead.

Cartilage has been used thus only as a secondary method, for the restoration of the contour and a completion of details impossible to

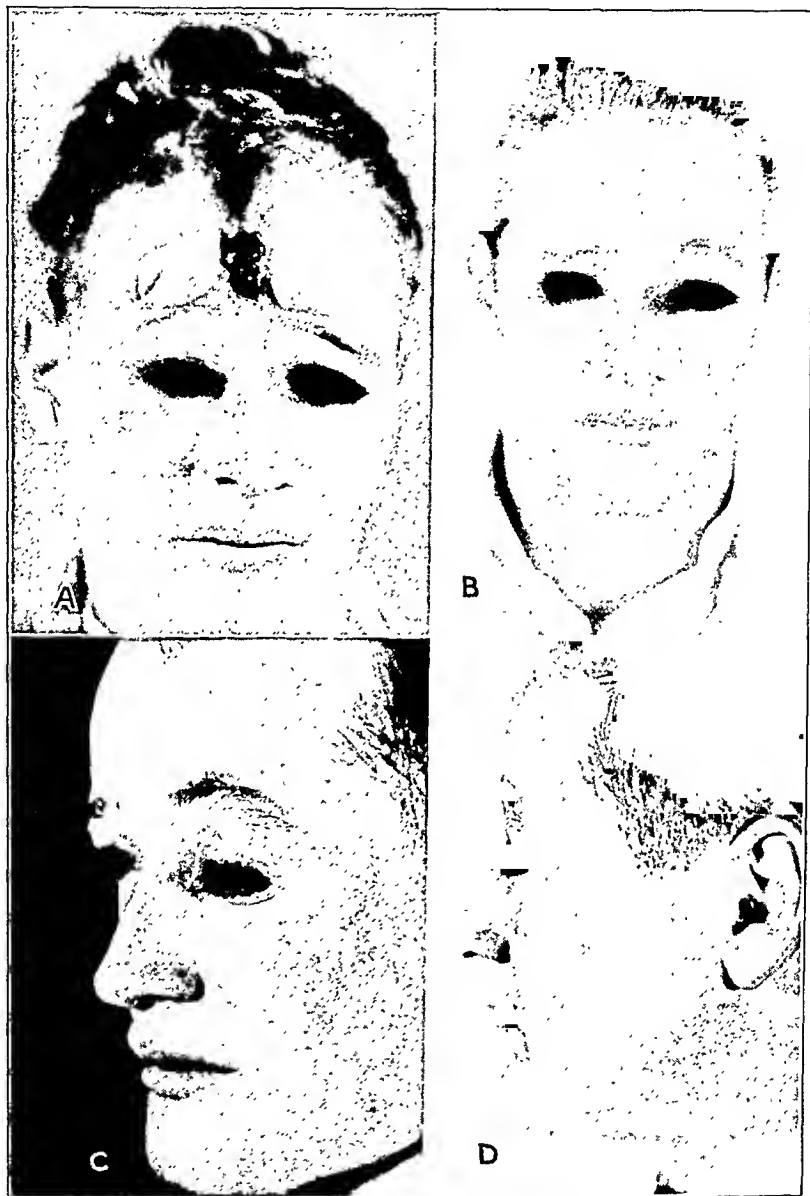


Fig. 8.—*A*, patient six months after resection of the frontal bone. *B*, patient after plastic closure of the skin flaps; depression due to absence of bone. *C* and *D*, patient after bone grafting; restoration of the normal contour of the forehead.

achieve with large bone grafts. For this, grafts are removed from the cartilage at the junction of the seventh, eighth and ninth ribs, shaped and buried under the skin in desired locations.

## COMPLICATIONS

Complications following the plastic repair were due to too early closure and have been previously reported. One patient died of abscess of the brain and meningitis. Although the complication cannot be attributed directly to this, the fact remains, as already mentioned, that closure was performed too early. In another case the elimination of sequestrums continued for months after an early closure of the flaps.

The possibility of convulsions following the plastic repair, due to adhesions between the dura and the skin or the grafted bone, has been considered. Epilepsy as a sequela of osteomyelitis was observed in 3 of the 18 cases reported. In all 3 cases the convulsions had occurred before the plastic operation and therefore could not be directly attributed to the latter procedure. It is noteworthy that the 3 patients presented evidence of intracranial complications at the time of their first admission to the hospital.

The first patient, aged 25, presented meningeal signs, stiffness of the neck and Kernig's sign. The lumbar puncture showed fluid under a pressure of 270, with 890 cells, 27 per cent of which were polymorphonuclears. She presented bilateral papilledema also. On resection of the frontal bone an extradural abscess was found. Four days after the operation she had her first generalized convulsion.

The second patient, aged 13, was admitted after jacksonian epilepsy on the left side. When the frontal bone was resected granulations covering the dura and an extradural abscess were found. After the operation the lumbar puncture showed fluid under a pressure of 180, with 13 cells, all lymphocytes. Examination of the fundi revealed bilateral papilledema.

The third patient, aged 22, showed stiffness of the neck without Kernig's sign. On lumbar puncture turbid fluid under a pressure of 200 was found, with 810 cells, 70 per cent of which were polymorphonuclears. The dura, after resection of the frontal bone, showed an area covered with granulations, although no definite extradural abscess was found. One month later, an abscess of the frontal lobe was localized and drained. Eighteen months later, the patient had her first general convulsive seizure. The attack of epilepsy occurred, however, before the plastic closure, the latter procedure having been purposely delayed after the appearance of these intracranial complications.

It is possible, therefore, to draw three general conclusions: first, that the convulsions were not due to the operative reconstruction; second, that the convulsions occurred in cases in which definite pathologic changes in the intracranial area were presented, and, third, that the soft tissue should not be closed until all suppuration has ceased and until the possibility of intracranial complications has been eliminated.

## CONCLUSIONS

The adoption of a radical procedure in dealing with osteomyelitis of the frontal bone has brought up the problem of secondary plastic repair of the deformity.



Plastic reconstruction should be considered only when suppuration and intracranial complications have been eliminated.

Except in cases of children, bony regeneration of the operative defect has not been observed.

The reconstruction is done in two stages. The first stage is a closure of the defect in the soft tissue. The second stage is the repair of the bony defect with bone grafts.

Epilepsy could not be attributed to the plastic operation and was observed only in cases in which intracranial complications were presented earlier, at or near the time of the operation for osteomyelitis.

### ABSTRACT OF DISCUSSION

DR. HARRIS P. MOSHER, Boston: This is a timely paper. It rounds out the report of the work on fulminating osteomyelitis of the frontal bone complicating infection of the frontal sinus which my associates and I have been doing for the past eight years at the Massachusetts Eye and Ear Infirmary. Why we see only the fulminating type, following swimming, I do not know. It sounds like an alibi to say that the severity of the infection of osteomyelitis may differ in different parts of the country. This, however, happens in infection of the mastoid. The epidemiology of osteomyelitis has not been worked out; neither has sulfanilamide or sulfapyridine entered the picture, as it will do in our next cases.

In the operative management of our cases we have settled down to a procedure which is practically routine, the only one which has given us increasingly better results and kept us from floundering about as we used to do. I am still waiting for some one to tell me how to determine at the beginning of an infection whether it will localize and the bone sequesterate or whether it will spread like wild fire. I am not advising a radical, deforming operation just from the lust for surgical procedure; until I get the information just mentioned I shall not trim my sails.

These frank statements will, I hope, dam up a little of the flood of oratory on the type of operation to be used, which I know from past experience is easily started. The type of operation is certainly not the main topic of the paper under discussion.

The operation for osteomyelitis of the frontal bone is simple. It is really an encircling operation. The only hard thing about it is to make up one's mind to do it and do it early. I have given up appeasement.

The radical operation for osteomyelitis is really a three stage operation. The first stage consists of the removal of the diseased bone, and the other two comprise the plastic repair of the deformity left by the first. No one likes to leave a patient markedly deformed after operation, as would be the case without the plastic repair which is the subject of Dr. Kazanjian's orderly, well reasoned, informative paper. On the basis of an impressive number of cases, he has given his present, up-to-date technic, which he has naturally bettered as the number of his cases has increased.

I should like to emphasize three points dealt with in the paper—the time of closure, the regeneration of bone and the occurrence of convulsions before or after the plastic closure.

The surgeon should err on the safe side in determining the time of closure. We have had trouble a few times with small sequestrums or the opening up of the lower part of the wound in the middle line when the closure was made before three months.

As to regeneration of bone, we have not been able to duplicate the experience of Furstenberg. In most of his reported cases the operative defect filled in with new bone. This is, of course, much to be desired. Dr. Kazanjian has had but 2 cases in which this has occurred, and both the patients were children. From the literature one gets the impression that the flat bones of the skull do not regenerate.

It is the common belief that bone regenerates chiefly from the periosteum. In talking with Dr. Kazanjian, I have gathered that he feels that we maltreat the periosteum by the hurried removal of bone and by the disturbance of frequent dressing and frequent inspection of the edges of the defect for progressive necrosis of the bone. I feel that there is something in this view and am in favor, since there is a wide open wound, of determining such a happening by roentgen examination, even though roentgen evidence is shown late. In other words, one can afford to wait a little if by so doing one gives the periosteum a better chance to bring about regeneration of bone.

It is comforting to learn of the 104 cases of successful transplantation of bone grafts to correct deformity reported by Delangenière. The size of the bone grafts used by Dr. Kazanjian is a bit startling. He gives convincing reasons why the bone graft should not be used at the original operation, however great and natural is the temptation.

It is likewise tempting to try filling the operative defect with the bone which has been removed at operation after sterilizing it or to use animal bone. However, it hardly seems worth while when there is plenty of live bone in the patient's nearby tibia from which an autogenous graft can be taken.

Convulsions may occur before or after the plastic closure. Dr. Kazanjian naturally would like to have them all occur before the plastic repair and cites 3 cases in which they did so occur. Convulsions in connection with osteomyelitis are due to scar tissue or to cysts of scar tissue.

Osteomyelitis is an ideal disease to cause scar tissue. The epileptic attack, so-called, are pressure convulsions like those of typical jacksonian epilepsy. Much as one dislikes to have them occur, they should cause no surprise. The wonder is that they do not occur more often. If they persist after a reasonable period of rest and observation the treatment is the obvious one of opening the incision and dissecting out the cyst or removing the offending scar if it can be located.

No surgeon is justified in assuming responsibility for a patient with fulminating osteomyelitis of the frontal bone unless he fully realizes what the frequent complications are and knows that he is dealing with one of the most fatal of surgical diseases. In no other part of the body has partial operation or watchful waiting more often proved disastrous.

The general surgeon is behind the times in treating this condition, as he is in treating deep abscess of the neck.

DR. VILRAY P. BLAIR, St. Louis: I think the last two remarks were bait thrown out to me, but I am not taking it. In the time allotted, I will stick to what I was asked to discuss—the treatment of a defect in the skull.

I was much interested in Dr. Kazanjian's use of the osteoperiosteal graft from the tibia. I have never performed that operation. My associates and I have observed defects of various sizes and from various causes, and in dealing with all there are two things at which to aim: One is to close the defect for the better function of the contents of the skull, and the other is to improve the appearance.

Some small defects we have filled with cartilage, and for larger ones we prefer the plan of chiseling off an adjacent thin layer of the outer table. We have roofed over large defects with rafters of closely placed ribs, the ends of which

were notched to fit shi lap at the edge of the defect, their natural curve partially restoring the dome shape. A large loss of the vertex, such as formerly was not infrequently encountered after "decompression operations" or epilepsy, is both crippling and unsightly. In such cases the Naffziger plan of transplanting a fitted corresponding piece of boiled calvarium is ideal if the graft is biologically acceptable to the tissues, and there is no real reason why the particular piece of bone could not be tried out in the patient's tissue before the real operation is undertaken.

For improving the appearance also I think one can use cartilage, and we have come to use fascia lata rather than the Eitner dermal grafts, because in our hands the former have proved more certain to take.

In a number of cases, cartilage smoothed out with fascia lata helps tremendously in giving the restoration desired.

Granting, for the sake of the present discussion, that Dr. Mosher is right in his premise that radical operation is the way to treat osteomyelitis, I think he is fortunate to have Dr. Kazanjian to cover up for him, which he has done beautifully.

# THE GALVANIC REACTION IN GUINEA PIGS

## III. THE REACTION FOLLOWING SECTION OF THE EIGHTH NERVE

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AND

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In two previous communications<sup>1</sup> we have discussed the galvanic reaction in normal and in unilaterally and bilaterally labyrinthectomized guinea pigs. The present study has to do with the galvanic reaction in guinea pigs in which the eighth nerve on one side was destroyed.

Dohlman<sup>2</sup> experimented with the galvanic reaction of animals in which the vestibular nerves were sectioned intracranially or in which the vestibular ganglion had been removed. He concluded that elicitation of galvanic nystagmus is dependent on integrity of the cells in the vestibular ganglion and their central connections. This conclusion is in agreement with that of Blau,<sup>3</sup> who found in cats, guinea pigs and an ape that nystagmus could still be elicited with the galvanic current when the labyrinth was completely destroyed. He proved by microscopic examination of the temporal bone that Scarpa's ganglion cells and the eighth nerve were still intact in these animals. Malassez,<sup>4</sup> after conducting examinations of deaf-mutes, concluded that the integrity of the semicircular canals is essential for postrotatory nystagmus but that the galvanic reaction can be obtained if a part at least of the vestibular nerve is still intact. Northington and Barrera,<sup>5</sup> working with monkeys,

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From the Department of Anatomy, the University of Mississippi Medical School.

1. Buchanan, A. R., and Ladd, L. D.: The Galvanic Reaction in Guinea Pigs: I. The Normal Galvanic Reaction, *Arch. Otolaryng.* **29**:124-135 (Jan.) 1939; II. The Reaction Following Labyrinthectomy, *ibid.* **29**:136-145 (Jan.) 1939.

2. Dohlman, G.: Experimentelle Untersuchungen über die galvanische Vestibularisreaktion, *Acta oto-laryng.* (supp.) **8**:1-48, 1929.

3. Blau: Experimentelle Studien über den galvanischen Nystagmus, *Ztschr. f. Ohrenh.* (supp.) **69**:6-7, 1913.

4. Malassez, J.: Excitation mécanique et électrique du vestibule chez les sourds-muets, *Compt. rend. Soc. de biol.* **89**:1256-1257, 1923.

5. Northington, P., and Barrera, S. E.: Induced Nystagmus in Monkeys Following Peripheral Vestibular Lesions, with Clinical Correlations, *Laryngoscope* **47**:729-754 (Oct.) 1937.

came to the conclusion that anatomically or functionally intact labyrinths are not necessary for the production of nystagmus by the galvanic current, but they found that an intact eighth nerve appears to be necessary for eliciting the response. In their opinion, a positive galvanic response (nystagmus) in the presence of a negative caloric response on the side on which there is vestibular dysfunction indicates that the eighth nerve on that side is not degenerated.

#### PROCEDURE

In the present study we destroyed the eighth nerve on the left side in 13 guinea pigs. The method employed for destruction of the nerve consisted of making a small drill hole through the skull, directly above the internal auditory meatus. An insulated electrode was inserted through this opening and forced down between the cerebellum and the lateral wall of the cranium. A right-angled projection at the distal end of the electrode was inserted into the internal auditory meatus, the tip of which was devoid of insulation. Orientation was simple, and a stop on the electrode indicated the approximate distance downward from the opening in the skull to the internal auditory meatus. Once oriented in the internal auditory meatus, the electrode could be held rigidly in place while a galvanic current of about 10 milliamperes was allowed to flow through the electrode. An indifferent electrode was attached to some point on the surface of the animal. The success of the procedure was evident at once, since the eyes immediately deviated toward the side on which the lesion was present, the right eye upward and the left downward. Since we used ether anesthesia for the procedure, the animals revived quickly, and spontaneous nystagmus toward the right became evident immediately. The animals also showed rotation of the head and concavity of the vertebral column toward the left, and they rolled violently in the same direction. Absence of the corneal reflex in the left eye indicated destruction of the seventh nerve, which was anticipated because of the close relation of this nerve to the eighth nerve in the internal auditory meatus.

Before operation a kymographic record of the galvanic falling reaction in each of these animals was obtained. It was ascertained also that the eyes moved normally in response to changes in the position of the animal in space (head up, head down and right and left lateral positions). Records of the galvanic falling reaction were made on the fourth and the fifteenth postoperative day. Caloric tests were carried out on the fifth and the sixteenth postoperative day. The methods utilized in testing the galvanic reaction have been discussed in previous papers.<sup>1</sup> The methods for testing the caloric reaction have been discussed in a previous communication by one of us (A. R. B.).<sup>6</sup>

On the fifteenth or the sixteenth postoperative day the animals were killed, after perfusion with neutral 10 per cent solution of formaldehyde, and the brains were fixed according to the method of Swank.<sup>7</sup> They were embedded in pyroxylin, sectioned and studied microscopically in order to determine whether the eighth nerve was completely degenerated.

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6. Buchanan, A. R.: Eye Deviation and Nystagmus in Guinea Pigs with Lesions of the Cerebellum and Brain Stem, *Laryngoscope* 47:874-900 (Dec.) 1937.

7. Swank, R.: Marchi Type Stains Counterstained with Cresyl Violet, *Anat. Rec. (supp.)* 61:63 (March) 1935.

## RESULTS

*Protocol.*—A protocol of a typical experiment follows. A guinea pig was tested for reactions to the galvanic current on Oct. 13, 1938, at which time 3 milliamperes of current was sufficient to elicit a reaction from either ear. Operation was performed on this animal on October 18. After the operation, which was performed with ether anesthesia, the animal rolled toward the left (the side on which the operation had been done); its eyes deviated toward the left, and there was spontaneous nystagmus to the right. The head was turned and rotated toward the left. There was also absence of the corneal reflex in the left eye, indicating paralysis of the seventh nerve.

October 19: All the symptoms of destruction of the eighth and of the seventh nerve seen immediately after the operation were still present.

October 21: All the symptoms were still present except the rolling toward the left. Galvanic tests carried out on this date (fourth postoperative day) showed an increase in the number of paradoxical reactions on both sides over that seen preoperatively, the greater number being elicited from the ear on the experimental side. On the normal side there were two paradoxical reactions per 10 stimuli, and on the side of operation, 5 such reactions. The currents required were also increased on both sides, being 5 milliamperes on the normal side and 15 milliamperes on the side of operation.

October 22: The deviation of the eyes persisted, but there was no longer spontaneous nystagmus. A caloric examination carried out on this date (fifth postoperative day) gave results as follows: Stimulation of the right ear gave nystagmus upward and forward in the right eye and downward and backward in the left. This nystagmus was easily elicited and had a normal duration. Caloric stimulation of the left ear gave a slight nystagmus in the opposite direction. The fact that there was some nystagmus from caloric stimulation of the left ear probably indicates that degeneration of the nerve was incomplete.

November 1: Rotation of the head to the left, deviation of the eyes to the left and paralysis of the left seventh nerve were still present. A galvanic test carried out on this date (fifteenth postoperative day) showed no paradoxical reaction from the normal ear, while there were still 5 such reactions per 10 stimuli from the opposite ear. The currents required were 3.5 milliamperes on the normal side and 19 milliamperes on the side of operation.

November 2 (sixteenth postoperative day): Caloric examination gave results as follows: Irrigation of the right ear elicited nystagmus forward and upward in the right eye and downward and backward in the left eye. No nystagmus could be elicited by stimulation of the left ear. The animal was killed. Neutral solution of formaldehyde was injected into the brain, and the organ was fixed according to the method of Swank.<sup>7</sup> Histologic study of the brain showed degeneration of the vestibular division of the eighth nerve on the left side. The degenerated fibers could be traced into the vestibular nuclei. Interestingly, some of these fibers apparently ran directly into the cerebellum. This supports the opinion of Lorente de Nó<sup>8</sup> and others. There was also considerable degeneration in the trapezoid body, due apparently to direct injury to the ventral cochlear nucleus.

*Paradoxical Reactions.*—Preoperatively, as has been true of each series of normal guinea pigs examined by this method, some paradoxical reactions were observed; of the total number of reactions observed in 13 animals, 6.3 per cent of those

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8. Lorente de Nó, R.: The Anatomy of the Eighth Nerve: Central Projection of the Nerve Endings of the Internal Ear, *Laryngoscope* 43:1-38 (Jan.) 1933.

elicited by stimulation of the right ear and 6.1 per cent of those elicited by stimulation of the left ear were in the wrong direction. On the fourth postoperative day there was an increase in the number of paradoxical reactions from the ears on both the surgically treated and the normal side. The greater number of paradoxical reactions, however, were observed on the side which had been operated on, averaging 5 paradoxical reactions per 10 stimuli, or 50 per cent; on the normal side there was an average of 3.63 paradoxical reactions per 10 stimuli, or a percentage of 35.3.

On the fifteenth postoperative day the number of paradoxical reactions was considerably less than on the fourth day, averaging 2.25 reactions per 10 stimuli on the normal side and 1.12 reactions on the side of operation. The percentage of paradoxical reactions on the normal side was 22.5, and on the side of operation, 11.2. It will be noted that on the fourth postoperative day, while paradoxical responses were increased on both sides, more were obtained from the side of operation. On the fifteenth day, on the other hand, more paradoxical responses were obtained from the normal than from the experimental side. Only 1 animal of the 13 showed

*Summary of the Results of Galvanic Stimulation of Thirteen Animals Before and After Section of the Eighth Nerve\**

Average Number of Paradoxical Reactions per Ten Stimuli (13 Animals)						Average Amount of Current, Milliamperes (13 Animals)					
Postoperative						Postoperative					
Preoperative		4 Days		15 Days		Preoperative		4 Days		15 Days	
Right	Left	Unop.	Op.	Unop.	Op.	Right	Left	Unop.	Op.	Unop.	Op.
0.63	0.61	3.53	5.00	2.25	1.12	2.65	2.61	5.92	9.15	2.81	6.76
6.3%	6.1%	35.3%	50.0%	22.5%	11.2%						

\* In this table, "right" indicates the electrode placed in the right ear; "left," the electrode placed in the left ear; "Unop.," the electrode placed in the ear on the side opposite the nerve section, and "Op.," the electrode placed in the ear on the side on which the nerve was sectioned.

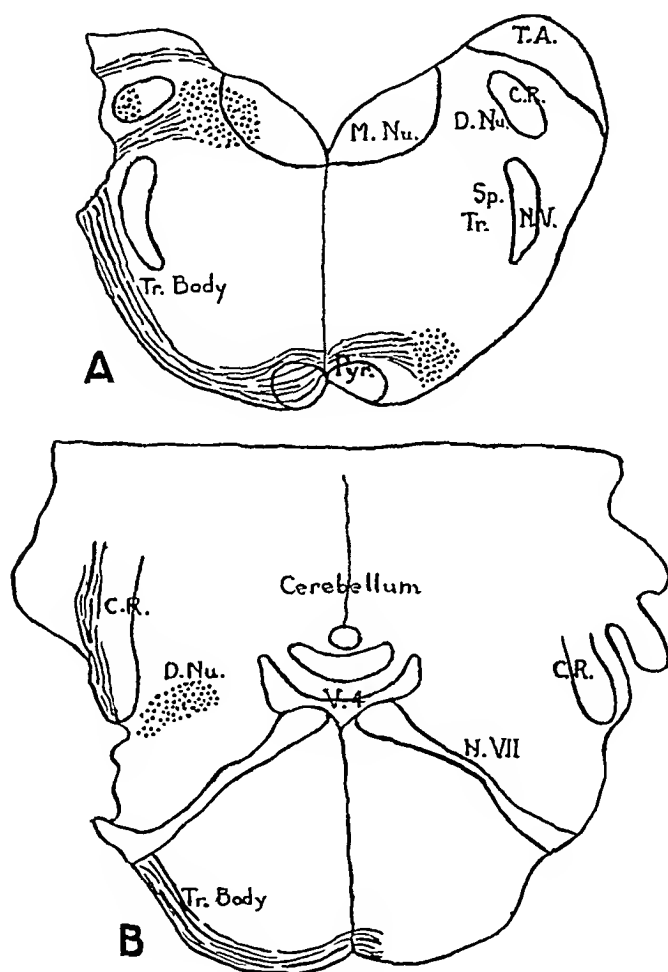
more paradoxical reactions on the experimental than on the normal side on the fifteenth day.

*Amount of Current Necessary for Responses.*—The average amount of current required for a galvanic reaction in this group of animals before operation was 2.65 milliamperes for the right ear and 2.61 milliamperes for the left ear. Postoperatively the amount of current required for a reaction was considerably increased. On the fourth day an average of 5.92 milliamperes was required for reactions from the ear on the normal side and an average of 9.15 milliamperes was required on the experimental side. By the fifteenth day the current required on the normal side was reduced to within normal limits, with an average of 2.81 milliamperes. On the side of operation it still required an average of 6.76 milliamperes to produce a reaction.

*Sign of More Effective Stimulus.*—Before operation anodal and cathodal stimulation of the ears were equally effective in producing a response in 34 per cent of cases; anodal stimulation was the more effective in 34 per cent, and cathodal stimulation in the remaining 32 per cent. On the fourth postoperative day anodal and cathodal stimulation were equally effective in 27 per cent of the cases; anodal stimulation was the more effective in 27 per cent, and cathodal stimulation in the

remaining 46 per cent. On the fifteenth postoperative day anodal and cathodal stimulation were equally effective in 13 per cent of the cases; anodal stimulation was the more effective in 31 per cent, and cathodal stimulation in the remaining 56 per cent.

As with the labyrinthectomized animals, cathodal stimulation of the ear tended to be more effective than anodal stimulation after operation. Before operation there was an almost equal distribution of the cases in which anodal and cathodal stimulation were equally effective, those in which anodal stimulation was the more effective and those in which cathodal stimulation was the more effective. After



Drawings of the brain stem. *T.A.* indicates the tuberculum acusticum; *C.R.*, the corpus restiforme; *D.Nu.*, Deiters' nucleus; *M.Nu.*, the medial vestibular nucleus; *Sp. Tr. N.V.*, the spinal tract of the fifth nerve; *Tr. Body*, the trapezoid body (degenerating); *V.4*, the fourth ventricle; *N.VII*, the seventh nerve; *Pyr.*, the pyramid.

the operation the cases in which cathodal stimulation was the more effective about equaled in number those in which the other two conditions held.

Sections of the brain stem of 1 of the guinea pigs are illustrated in the accompanying figure. It represents the picture in each of the 13 animals included in this report. In *A* the degenerated fibers of the vestibular division of the eighth nerve can be seen terminating in the vestibular nuclei. The trapezoid fibers from the ventral cochlear nucleus are also shown running ventrally and medially to cross the midline and form the lateral lemniscus. The degeneration of the trapezoid



body is accounted for by direct injury to the ventral cochlear nucleus, which is also clearly evident in the figure. In *B* the seventh nerve can be seen emerging from the brain stem, which, of course, indicates the level at which the vestibular nerve enters; it can be seen that a portion of the brain stem was actually destroyed at the point of entrance of the nerve. Even though the degeneration of the fibers of the eighth nerve terminating in the vestibular nuclei on the left side were not evident, the actual destruction of tissue peripherally at the point of entrance of the eighth nerve would prove beyond doubt that the vestibular division of the eighth nerve was completely severed.

#### COMMENT AND SUMMARY

The galvanic falling reaction has been tested in guinea pigs with unilateral destruction of the eighth (auditory and vestibular) and the seventh nerve. Contrary to our expectations and contrary to the results obtained by some previous investigators, the reaction was still elicitable in these animals. Previous investigators, however, including Dohlman,<sup>2</sup> Blau,<sup>3</sup> Malassez<sup>4</sup> and Northington and Barrera,<sup>5</sup> studied not the galvanic falling reaction but galvanic nystagmus. We have not made careful observations on nystagmus as elicited by the galvanic current, but further studies which will include a study of both phenomena are necessary.

In our study of the galvanic reaction of unilaterally labyrinthectomized guinea pigs it was found that paradoxical reactions occurred more frequently on the side which was not operated on than on the side of the labyrinthectomy. In the animals in which the eighth nerve was destroyed unilaterally it was found that paradoxes occurred on stimulation of the ears on both sides; on the fourth postoperative day the average percentage of paradoxical reactions was 35.3 on the normal side and 50 on the side of operation; on the fifteenth day the paradoxical reactions occurred about twice as frequently on the normal as on the experimental side, the percentage being, respectively, 22.5 and 11.2.

In the unilaterally labyrinthectomized animals greater amounts of current were required on both sides, but considerably more was required on the labyrinthectomized side. This was true on the fourth postoperative day in the animals with the eighth nerve destroyed, when the average current required on the normal side was 5.92 milliamperes, as compared with 2.65 milliamperes on the same side before operation, and 9.15 milliamperes on the experimental side, as compared with 2.61 milliamperes on the same side before operation. On the fifteenth postoperative day, however, the average current required on the normal side was practically the same as before operation (2.81 milliamperes). On the experimental side 6.76 milliamperes was required to elicit a reaction.

As in the labyrinthectomized animals, cathodal stimulation of the ears seemed to be more effective in the surgically treated than in the normal guinea pigs.

Differentiation between disease of the labyrinth and disease of the eighth nerve would be impossible on the basis of this test, since the reactions in the wrong direction increased on both sides in both types of animals and in about the same proportion. The variations in the strength of current required were essentially the same in the two conditions.

The fact that the galvanic falling reaction persisted after destruction of the eighth nerve indicates that some other mechanism must function in this reaction. What this mechanism may be is difficult to say. It may be that the tenth nerve, particularly through the division known as Arnold's nerve, which furnishes the sensory supply to the external auditory meatus, may transmit the stimulus to the proper brain centers, whatever they may be. Other nerves which must be considered include, of course, the fifth, the ninth, the tenth and the eleventh cranial nerve, and possibly the upper cervical nerves. It will be necessary to devise some means of eliminating these nerves one at a time and, it seems to us, in one and the same animal in order to obtain definite information as to the part which they may play in the galvanic falling reaction.

# THE GALVANIC REACTION IN GUINEA PIGS

## IV. THE REACTION IN ANIMALS WITH UNILATERAL LESIONS IN THE BRAIN STEM

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Previous reports have described the galvanic reaction in guinea pigs with unilateral labyrinthectomy and with unilateral destruction of the eighth nerve.<sup>1</sup> It has been shown, contrary to the findings in human subjects reported by Blonder,<sup>2</sup> that the reaction is still elicitable after destruction of the labyrinth, although requiring a considerably stronger current. This is in agreement with the findings reported by Blau<sup>3</sup> and others, including those in the recent report of Northington and Barrera.<sup>4</sup> After destruction of the eighth nerve the galvanic falling reaction could still be elicited, but, again, a stronger current was required than for normal animals. Dohlman,<sup>5</sup> Northington and Barrera<sup>4</sup> and others have found that galvanic nystagmus cannot be elicited after destruction of the eighth nerve.

The nervous structures involved in the galvanic falling reaction seem, logically, to include: (1) the labyrinth; (2) the vestibular division of the eighth nerve; (3) the vestibular nuclei, and (4) the descending pathways from the vestibular nuclei, including the vestibulospinal tract and the medial longitudinal fasciculi. Any explanation why a pathway so constituted should be responsible for an almost constant falling reaction toward the anode and away from the cathode when galvanic current is allowed to flow through the ear is, so far as I know, still lacking. Since

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From the Institute of Neurology, Northwestern University Medical School, and the Department of Anatomy, University of Mississippi Medical School.

1. Buchanan, A. R., and Ladd, L. D.: The Galvanic Reaction in Guinea Pigs: II. The Reaction Following Labyrinthectomy, *Arch. Otolaryng.* **29**:136-145 (Jan.) 1939; III. The Reaction Following Section of the Eighth Nerve, *ibid.*, this issue, p. 113.

2. Blonder, E. J.: Galvanic Falling in Clinical Use, *Arch. Neurol. & Psychiat.* **37**:137-141 (Jan.) 1937.

3. Blau: Experimentelle Studien über den galvanischen Nystagmus, *Ztschr. f. Ohrenh. (supp.)* **69**:6-7, 1913.

4. Northington, P., and Barrera, S. E.: Galvanic Nystagmus Reaction in the Monkey, *Am. J. Physiol.* **120**:703-704 (Oct.) 1937.

5. Dohlman, G.: Experimentelle Untersuchungen über die galvanische Vestibularisreaktion, *Acta oto-laryng. (supp.)* **8**:1-48, 1929.

the galvanic falling reaction can be elicited after destruction of the labyrinth or after destruction of the eighth nerve, the hypothesis seems to be in error in describing either the first or the second or both the first and the second portion of the pathway; if it is not in error, other structures must be accessory to these portions. The latter seems to be true, since elimination of the labyrinth or of the eighth nerve does not eliminate the reaction but does necessitate the use of larger amounts of current. Furthermore, the tendency of animals with either of these structures destroyed to react toward the anode is considerably less constant.

It may be that a study of the reaction following destruction of the third or central portion of the hypothetic pathway (the vestibular nuclei) is not indicated until the peripheral pathway has been more definitely determined. Nystagmus, as elicited by galvanic, caloric and rotatory stimulation has, however, been studied by Dohlman<sup>5</sup> after extirpation of the triangular (medial) vestibular nucleus. He found that post-rotatory and caloric nystagmus could still be elicited but that galvanic nystagmus was no longer elicitable. Blonder and Davis<sup>6</sup> studied the galvanic reaction in patients with intracranial tumors and found that the average amount of current required to produce falling in those with supratentorial lesions was less than that required in those with infratentorial lesions. Since there has been an attempt to utilize the reaction clinically, in the diagnosis of lesions in the brain stem, it seems that the results obtained in a series of guinea pigs with lesions in the brain stem are significant.

#### PROCEDURE

Kymographic records of the galvanic reactions in 15 normal guinea pigs were made, and the animals were subsequently operated on. Lesions were placed in the brain stem by means of a Horsley-Clarke stereotaxic instrument; all the lesions were unilateral and all were on the left side. In 6 animals the lesions involved the lateral vestibular nucleus, or nucleus of Deiters (series 1, table); in 7 animals there was destruction in the medial vestibular nucleus (series 2, table); in 4 animals there was involvement of the descending vestibular nucleus (series 3, table). The use of the horizontal electrode obviated any injury to the cerebellum.

Postoperative tests of the galvanic reaction were carried out on the fourth and on the fifteenth day. In all the galvanic tests local nupercaine anesthesia was used at the points of application of the electrodes. The detailed technic of the galvanic determinations has been reported previously.<sup>7</sup>

Nine of the animals included in the table were operated on a second time at the end of the fifteenth days' observation, a second lesion being placed on the same

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6. Blonder, E. J., and Davis, L.: The Galvanic Falling Reaction in Patients with Verified Intracranial Neoplasms, *J. A. M. A.* **107**:411-412 (Aug. 8) 1936.

7. Buchanan, A. R., and Ladd, L. D.: The Galvanic Reaction in Guinea Pigs: I. The Normal Galvanic Reaction, *Arch. Otolaryng.* **29**:124-135 (Jan.) 1939.

Animal No.	Site of Lesion*	Number of Paradoxical Reactions per 10 Stimuli						Amount of Current in Milliamperes									
		Preoperative			Postoperative			Preoperative			Postoperative						
		4th Day			15th Day			4th Day			15th Day						
		Electrode on Right Side	Electrode on Left Side	Electrode on Intact Side	Electrode on Injured Side	Electrode on Intact Side	Electrode on Injured Side	Electrode on Right Side	Electrode on Left Side	Electrode on Intact Side	Electrode on Injured Side	Electrode on Right Side	Electrode on Left Side	Electrode on Intact Side	Electrode on Injured Side		
Series I																	
114	Delors' nucleus; inferior cerebellar peduncle; eighth nerve.....	0	0	4.4	5	+	+	4	2.5	2.5	5	+	+	+	+	+	+
115	Delors' nucleus (slight); inferior cerebellar peduncle.....	0	0	4.4	4.7	0.77	7	2.5	4	3	10	3	3	3	3	3	3
123	Delors' nucleus; spinal tract and nucleus of the fifth nerve.....	0	0	0	2	3	0	2.5	3	2	2	2	2	2	2	2	2
135	Delors' nucleus (slight); descending nucleus; lateral cuneate nucleus; spinal nucleus of the fifth nerve.....	0	1.4	5	0.77	+	+	3	3	4	4.5	+	+	+	+	+	+
129	Delors' nucleus; medial nucleus.....	0	0	0	0	0	0	2.5	2.5	4	5.5	3.5	3	3	3	3	3
130	Delors' nucleus; medial nucleus; uncinate fasciculus (of Russell); genu of the seventh nerve.....	2	0	0	0	+	+	2	2	2.5	2.5	+	+	+	+	+	+
	Average.....	0.33	0.23	2.3	2.08	1.20	2.33	2.75	2.83	3.00	4.91	2.83	2.83	2.83	2.83	2.83	2.66
	Percentage.....	3.3	2.3	23	20.8	12.6	23.3										
Series II																	
118	Medial nucleus (slight); medial reticular formation.....	0	0	2.5	0.9	0	1	2.5	2.5	3	3	2.5	2.5	2.5	2.5	2.5	2.5
119	Medial nucleus (slight); medial reticular formation.....	0	0	2	3.7	0	0.71	5	5	4	4	2	2	2	2	2	2
120	Medial nucleus; medial reticular formation.....	0	0	+	+	+	+	?	?	+	+	+	+	+	+	+	+
121	Medial nucleus.....	0	0	5.7	5	+	+	2.5	2.5	5	5	+	+	+	+	+	+
134	Medial nucleus (slight); reticular formation.....	0	0	0	0	4.1	0	3	4	3	2.5	2	2	2	2	2	2
129	Medial nucleus; Delors' nucleus.....	0	0	0	0	0	0	2.5	2.5	5	5	+	+	+	+	+	+
132	Medial nucleus; spinal nucleus of the fifth nerve.....	0	0	0.83	0	2.8	0	3.5	3	4	2	5	5	5	5	5	5
	Average.....	0	0	1.84	1.60	1.38	0.34	3.16	3.25	3.83	3.66	3.00	3.00	3.00	3.00	3.00	2.70
	Percentage.....	0	0	18.4	16.0	13.8	3.4										
Series III																	
117	Descending nucleus.....	0	0	0	0.77	0	5	3	4	2.5	5	4	4	4	4	4	4
128	Descending nucleus.....	0	0	5	5	0	0	3	3	10	7	2	2	2	2	2	2
135	Descending nucleus; Delors' nucleus (slight); lateral cuneate nucleus; spinal nucleus of the fifth nerve.....	0	1.4	5	0.77	+	+	3	3	4	4.5	+	+	+	+	+	+
133	Descending nucleus (slight); lateral reticular formation; eighth nerve.....	0	0	3	1.6	+	+	2.5	3.5	2.5	2.5	+	+	+	+	+	+
	Average.....	0	0.36	3.25	2.03	0	2.5	2.87	3.37	4.75	4.75	3.00	3.00	3.00	3.00	3.00	3.00
	Percentage.....	0	3.6	32.5	20.3	0	25										
	General average.....	0.12	0.16	2.36	1.89	1.07	1.37	2.94	3.12	3.75	4.42	2.75	2.75	2.75	2.75	2.75	2.95
	Percentage.....	1.2	1.6	23.6	18.9	10.7	13.7										

\* All lesions were unilateral, on the left.

side of the brain stem. Postoperative observations were made on these animals in exactly the same manner as after the first operation.

On termination of the postoperative study, the animals were killed, and the brains were removed, fixed and studied by means of the Weil<sup>8</sup> and cresyl violet<sup>9</sup> stains, which facilitated accurate localization of the lesions.

## RESULTS

*Paradoxic Reactions.*—The number of paradoxical reactions per ten stimuli for the entire group of animals before operation averaged 0.12 on stimulation of the right ear and 0.16 on stimulation of the left ear (table); the respective percentages were 1.2 and 1.6. The percentage of paradoxical responses on the fourth day after operation was 23.6 on the intact side and 18.9 when the electrode was in contact with the ear on the side of the lesion. On the fifteenth postoperative day the respective percentages were 10.7 and 13.7.

If one considers only the 6 animals with lesions involving Deiters' nucleus (series 1, table), the preoperative paradoxes occurred in 3.3 per cent of cases when the right ear was the site of stimulation and in 2.3 per cent when the left ear was stimulated. On the fourth postoperative day 23 per cent of the reactions from the ear on the intact side and 20.8 per cent of the reactions from the ear on the side of the lesion were in the wrong direction. Fifteen days after operation the respective percentages were 12.6 and 23.3.

Separate consideration of the 7 animals with involvement of the medial vestibular nucleus reveals that there were no paradoxical reactions in this group before operation (series 2, table). On the fourth postoperative day the intact and the injured side showed respectively 18.4 per cent and 16 per cent paradoxical reactions. On the fifteenth day the respective percentages were 13.8 and 3.4.

Only 1 of the 4 animals having involvement of the descending nucleus gave any paradoxical responses before operation, this animal (135) reacting in the wrong direction 14 per cent of the time. The average percentage of paradoxical reactions in this group (series 3, table) was 0 on the right and 3.6 on the left. Four days after operation the percentages were 32.5 on the intact side and 20.3 on the side of the lesion. On the fifteenth day there were no paradoxical reactions from the intact side, and 25 per cent of the reactions from the side of the lesion were in the wrong direction.

*Amount of Current in Milliamperes.*—The average number of milliamperes required for elicitation of the falling reaction before operation

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8. Weil, A.: A Rapid Method for Staining Myelin Sheaths, *Arch. Neurol. & Psychiat.* 20:392-393 (Aug.) 1928.

9. Tress, G., and Tress, M.: A Modification of the Cresyl Violet Technic for Staining Nerve Cells, *Stain Technol.* 10:105-106, 1935.

in this group of animals was 2.94 for the right ear and 3.12 for the left ear. There was a slight increase in the amount of current required on the fourth day after operation (3.75 milliamperes on the intact side and 4.42 on the side of the lesion), but the increase was equal or practically equal on the injured and the intact side, this being true of the general average and also of the average for each of the three series of animals (table). On the fifteenth day after operation the average requirement of current was within normal limits on both the injured and the intact side (2.75 and 2.95 milliamperes).

*Results of Second Operation.*—As previously stated, 9 of the animals included in this report were operated on a second time, following the first fifteen days' observations, and a second lesion was placed on the same side of the brain stem; a detailed discussion of the areas involved by these supplementary lesions will be omitted. There was, however, approximately twice as much destruction in the left half of the brain stem of these animals as existed after the first operation. In these, on the fourth postoperative day, 36.3 per cent of the reactions from the ear on the intact side were in the wrong direction, or paradoxical, and 19.8 per cent of those from the side of the lesion were in the wrong direction. The requirement of current was 5.22 milliamperes on the intact side and 4.44 on the side of the lesion. On the fifteenth day there were still about twice as many paradoxical reactions from the ear on the intact side as from that on the side of the lesion, the respective percentages being 13.5 and 6.8. At this time the requirement of current was again well within the normal range, being 2.25 milliamperes on the intact side and 3 on the side of the lesion.

*Sign of the More Effective Stimulus.*—Careful analysis has shown that there was no tendency for the galvanic current to be more effective when either the cathode or the anode was in contact with the ear. In this respect, the animals differed from those with lesions in the labyrinth or the eighth nerve, in which cathodal stimulation appeared to be more effective than anodal.

#### DISCUSSION

Obviously, the galvanic falling reaction might serve a most useful purpose clinically, if lesions in the brain stem could be localized to one or the other side by means of it. If the vestibular nuclei form a link in the pathway which effects the galvanic falling reaction, it seems that one might expect a change in the reaction to follow unilateral destruction of the nuclei or their connections. Unfortunately, however, the differences in the requirement of current on the injured and the intact side were insignificant. Furthermore, the number of paradoxical reactions per ten stimuli was not significant in lateral localization of the lesion, being slightly greater on the intact side on the fourth postoperative day

and slightly greater on the side of the lesion on the fifteenth day, except in the animals which were studied after a second lesion had been placed in the brain stem. In the latter series of guinea pigs, the number of paradoxical reactions from the ear on the intact side was approximately twice as great as the number from the side of the lesion on both the fourth and the fifteenth postoperative day. The results in these animals seem to indicate a tendency toward an increase in paradoxical reactions from stimulation of the ear on the intact side, a tendency similar to that in guinea pigs with lesions in the labyrinth or the eighth nerve. The electrolytic lesions produced in these animals are, of course, static if not actually regressive; it seems probable that an increase in paradoxical reactions might regularly accompany expanding lesions. If more massive lesions were compatible with postoperative recovery in guinea pigs, an increase in the number of paradoxical reactions, even on the fifteenth postoperative day, might probably be observed after a single operation. The placing of a second lesion at a later date should bring about essentially the same effect.

The fact that paradoxical reactions occur more frequently on both sides, but especially on the intact side, in guinea pigs with lesions in the labyrinth, the eighth nerve or the vestibular nuclei, destroys the value of the test in differentiating any one of these conditions from the other two. The amount of current required does become significant in differentiation; in the animals with central lesions, increase in the requirement of current was minimal on the fourth day and absent on the fifteenth; in those with destruction of the labyrinth there was a considerable increase in the amount of current required on the side of the lesion; section of the eighth nerve still further increased the amount of current required to elicit the galvanic falling reaction.

Dohlman's conclusions<sup>5</sup> were not verified, although it must be noted that they were based on studies of galvanic nystagmus rather than on the galvanic falling reaction. Caloric and postrotatory nystagmus could be elicited in each of the 7 animals in series 2, table, which had lesions involving the medial vestibular nucleus. The galvanic falling reaction also was elicitable in these animals, although somewhat modified as shown in the table and discussed.

Caloric and rotatory tests produced nystagmus in all the guinea pigs included in the table. Modifications in the caloric and postrotatory nystagmus over that seen in normal animals will be discussed in another communication.

#### SUMMARY

1. Paradoxical reactions were increased on stimulation of the ears on both the injured and the intact side in guinea pigs with electrolytic lesions in the left half of the brain stem. When the lesions were exten-



sive, the number of paradoxical reactions from the intact side was about twice as great as that from the side of the lesion, a condition which was found to exist also in animals with lesions in the labyrinth or the eighth nerve.

2. Significant increases in the number of milliamperes of current required to elicit galvanic falling reactions on stimulation of either ear were not observed, even in animals having extensive destruction of the vestibular nuclei or the reticular formation.

3. The galvanic current did not tend to be more effective when either the cathode or the anode was in contact with the ear.

4. Caloric and postrotatory nystagmus were elicitable in these guinea pigs, although modified over that seen in normal animals.

# ARGYRIA RESULTING FROM INTRANASAL MEDICATION

A CLINICAL AND EXPERIMENTAL STUDY

BEN L. BRYANT, M.D.

LOS ANGELES

Despite the warnings that have appeared occasionally in the literature, many otolaryngologists still deny the danger of the production of generalized argyria from the use of silver-containing intranasal medication. This heedless attitude is abetted by the advertisements of certain manufacturers of such medications. One of them states quite consistently in the advertising pages of medical publications that the solution is "non-toxic, definitely bacteriostatic, and above all, it is markedly soothing to inflamed tissues."

The physician who has seen even a single victim of full-blown argyrosis, with its typical generalized pigmentation of the skin, giving the patient a bronzed blue or slate color which has been described aptly as the appearance of a corpse suddenly come to life, must necessarily have been impressed with the importance of preventing such a condition. Prevention is actually the only treatment, for, although Stillians<sup>1</sup> and others have shown that by painstaking and multitudinous injections of a 1 per cent solution of potassium ferrocyanide and a 6 per cent solution of sodium thiosulfate in distilled water the skin of the face and neck can be cleared of the pigmentation, a person with the general discoloration due to the distribution of silver will retain it for all of his days.

In the earliest cases reported argyria was caused by the internal use of silver nitrate, but as this form of therapy was relinquished the incidence of argyria naturally diminished, until, within the past generation, the use in the nose and throat of medications containing silver was introduced, with the resultant recrudescence of the lamentable condition.

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From the Otolaryngological Research Department of the Good Hope Clinic.

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Read before the Section on Laryngology, Otology and Rhinology at the Ninetieth Annual Session of the American Medical Association, St. Louis, May 17, 1939.

1. Stillians, A. W.: Argyria, Arch. Dermat. & Syph. **35**:67-77 (Jan.) 1937.

That argyrosis can and does occur as a direct result of intranasal silver therapy is not denied by those who have had the opportunity to see a large number of patients and who have been alert to perceive the changes in the membranes of the nose and throat and the beginning generalized pigmentation. Some physicians continue to use the dangerous medications because argyria develops comparatively rarely and they feel vaguely that it must be due to some individual physiochemical state. The reason for the apparent disparity between cause and effect was explained by Gaul and Staud.<sup>2</sup> With their biospectrometric analysis (which, incidentally, presents the most convenient and precise method of diagnosis), they have shown that the photochemical action of light produces clinically recognizable argyria when the system contains an amount of silver equal to 8 Gm. of silver arsphenamine. All human beings carry a certain amount of silver with them—in the cells of their bodies—which they have acquired from cooking utensils and cutlery and, in some cases, from the catalytic action between gold and silver dental inlays. If, therapeutically, there is added enough to bring the individual content to the figure mentioned, argyria and its pigmentation are apt to appear.

That the silver which is absorbed is deposited in all the organs of the body has been shown by many workers, among them Blumberg and Carey,<sup>3</sup> Scheffel,<sup>4</sup> Gettler, Gellhorn<sup>5</sup> and Gaul and Staud.<sup>2</sup> It is permanently fixed in the form of small black or grayish granules and has a predilection for connective tissue and elastic fibers. Huet<sup>6</sup> in 1873 and von Kahlden<sup>7</sup> in 1894 reported similar findings in experimental animals which had been given silver nitrate by mouth. Von Kahlden stated that he had seen intracellular silver granules, in contradistinction to many authors, who state that the silver is seldom seen within cells. It is found in the subpapillary layer of the skin and the mucous membranes. Gaul and Staud<sup>2</sup> explained the retention of silver in connective

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2. Gaul, L. E., and Staud, A. H.: Clinical Spectroscopy: Study of Biopsy Material from Patients Who Had Received Intravenous Injections of Silver Arsphenamine, *Arch. Dermat. & Syph.* **30**:433-438 (Sept.) 1934; Clinical Spectroscopy: Seventy Cases of Generalized Argyrosis Following Organic and Colloidal Silver Medication, Including Biospectrometric Analysis of Ten Cases, *J. A. M. A.* **104**:1387-1390 (April 20) 1935.

3. Blumberg, H., and Carey, T. N.: Argyremia: Detection of Unsuspected and Obscure Argyria by Spectrographic Demonstration of High Blood Silver, *J. A. M. A.* **103**:1521-1524 (Nov. 17) 1934.

4. Scheffel, C.: The Physiochemistry of Argyria, *M. Rec.* **140**:205-207, 1934.

5. Gellhorn, G.: Argyria Uteri, *Am. J. Obst. & Gynec.* **31**:613-618, 1936.

6. Huet, M.: Recherches sur l'argyrie, *J. de l'anat. et physiol.* **9**:408, 1873.

7. von Kahlden, C.: Ueber die Ablagerung des Silbers in den Nieren, *Beitr. z. path. Anat. u. z. allg. Path.* **15**:611-625, 1894.

tissue as well as its distribution and excretion by cellular response and the engulfing of the particles by phagocytosis.

Scheffel<sup>4</sup> stated that argyria is caused by the overloading of tissue cells with excessive strengths and added that low concentrations can produce argyria in dehydrated patients or in those with an excessive chloride content in the blood or tissues. Thus the argyria occasionally becoming manifest during pregnancy is an indirect result of vomiting, causing dehydration, which prevents the silver from leaving the cells.

A case representative of several which I have observed and serving to emphasize the situation which results from the ill advised use of silver salts in the nose is that of a 40 year old university professor who when seen first had been treated daily for the preceding three months with a 10 per cent solution of mild protein silver in the form of Dowling packs for the relief of symptoms indicative of chronic ethmoiditis. In addition, he had treated himself on various occasions with nose drops of mild protein silver and cotton applicators soaked with the same substance in the nose. His throat was normal on casual inspection, but viewed with the postnasal mirror the entire nasopharynx looked as though it had been sprayed with soot, and examination of the nose showed that every millimeter of the mucosa was almost black. The only other areas of pigmentation were the finger nails and the conjunctival cul-de-sacs of the lower eyelids. This patient had not had direct instillations of mild protein silver in the eyes except on three widely separated occasions.

Figure 1 is a photomicrograph under high power magnification of tissue removed from the anterior end of the right inferior turbinate of this patient and shows the widespread distribution of silver in the form of grayish black granules in the sub-mucosal tissue, particularly around and in the walls of the blood vessels and in the connective tissue. It is obvious that generalized pigmentation of the skin would have been the fate of this patient, as it has been in many similar instances, had the medication not been discontinued. When it was discontinued and therapy was instituted which permitted the normal physiologic action of the mucosal cilia, his nasal symptoms disappeared. Colloidal silver preparations, as has been demonstrated by Proetz<sup>8</sup> and others, markedly slow the ciliary action by mechanical clogging.

Incidentally and interestingly, after several months the color of the nasal membranes had lightened considerably, indicating that absorption does take place directly from the site of application, despite the rather widespread opinion that the silver is absorbed only from the intestinal tract, after conversion to silver albuminate, and that, therefore, if argyrosis follows intranasal medication it must be because of the solution which is swallowed.

This observation would tend to support the theory of Virchow that reduction and absorption occur at the site of application. This is further

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8. Proetz, A. W.: Treatment of Sinus Disease, *Pennsylvania M. J.* 39:385-389, 1936; Nasal Ciliated Epithelium, *J. Laryng. & Otol.* 49:557-570, 1934; Effects of Certain Drugs upon Living Ciliated Epithelium, *Ann. Otol., Rhin. & Laryng.* 43:450-463, 1934.

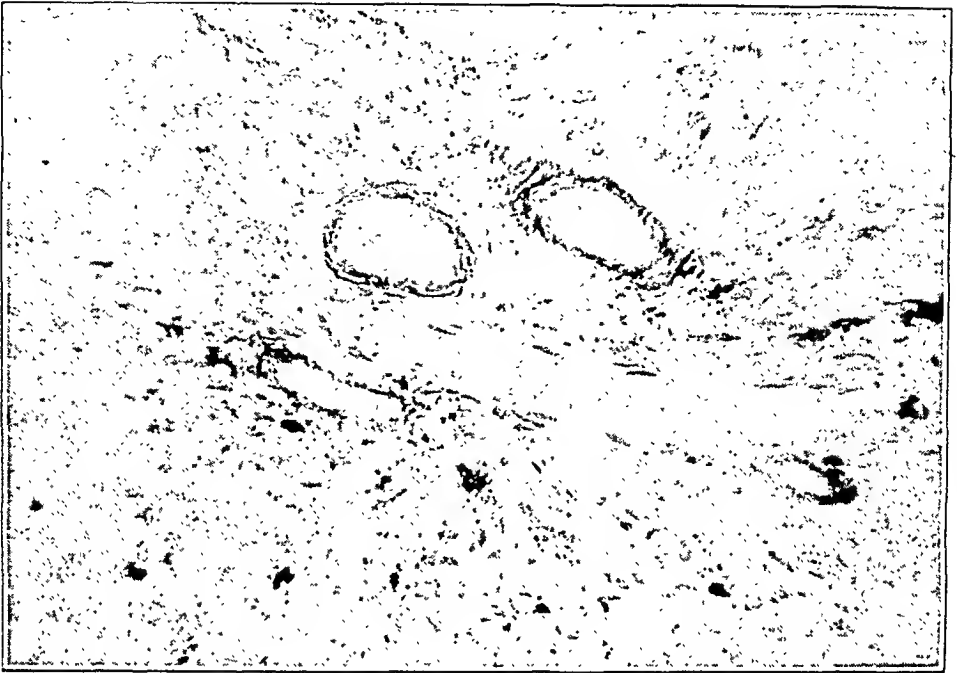


Fig. 1.—High power photomicrograph of tissue removed from the anterior end of the right inferior turbinate of a patient with argyria.

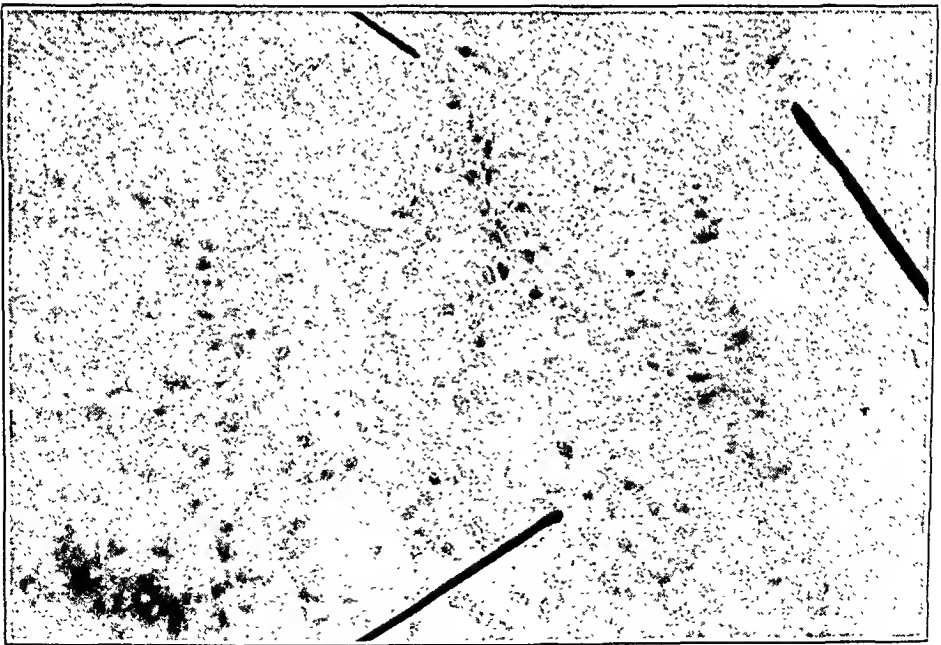


Fig. 2.—High power photomicrograph of tissue from the nasal passages of rabbit 1 (argyrol drops).

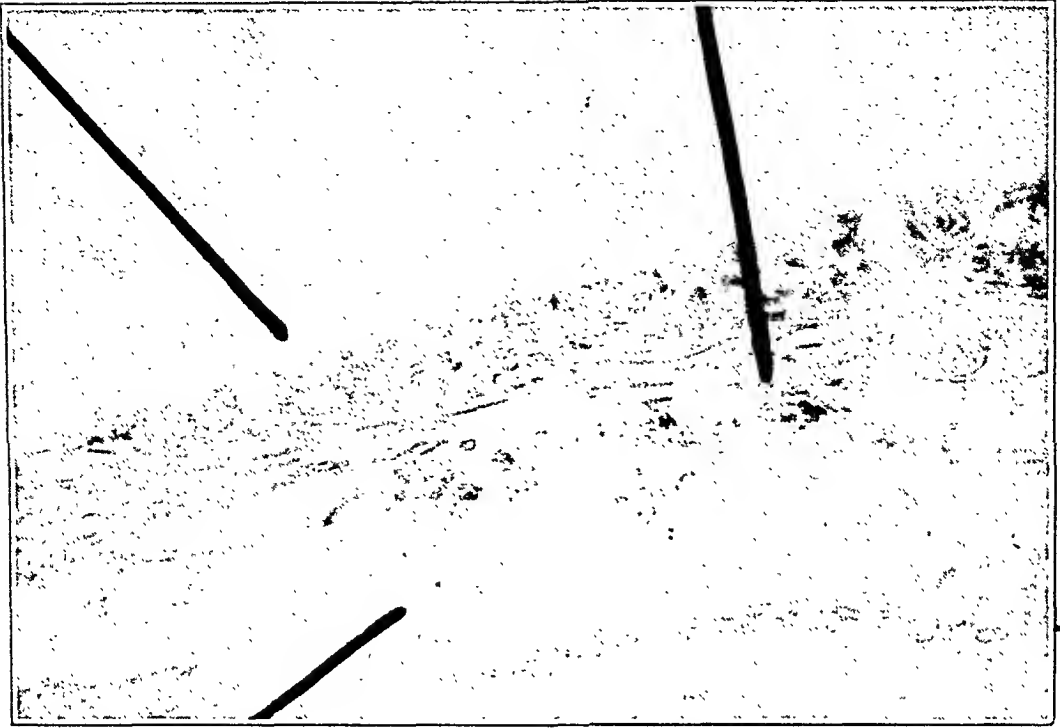


Fig. 3.—High power photomicrograph of tissue from the nasal passages of rabbit 2 (argental drops).

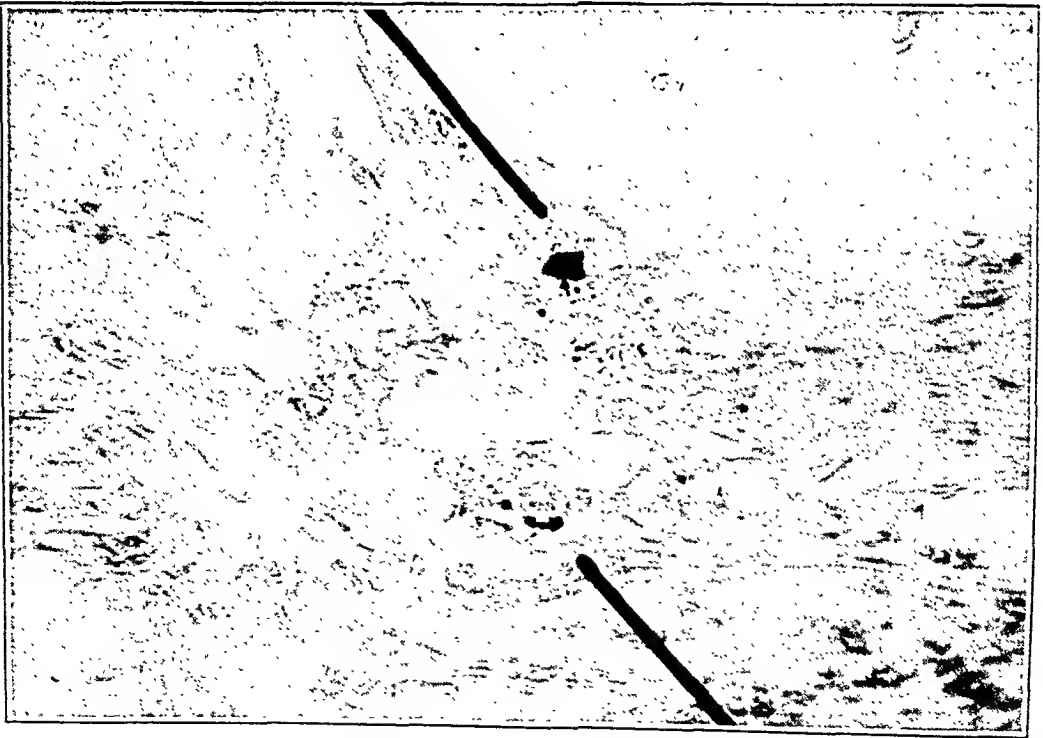


Fig. 4.—High power photomicrograph of tissue from the nasal passages of rabbit 3 (neo-silvol drops).

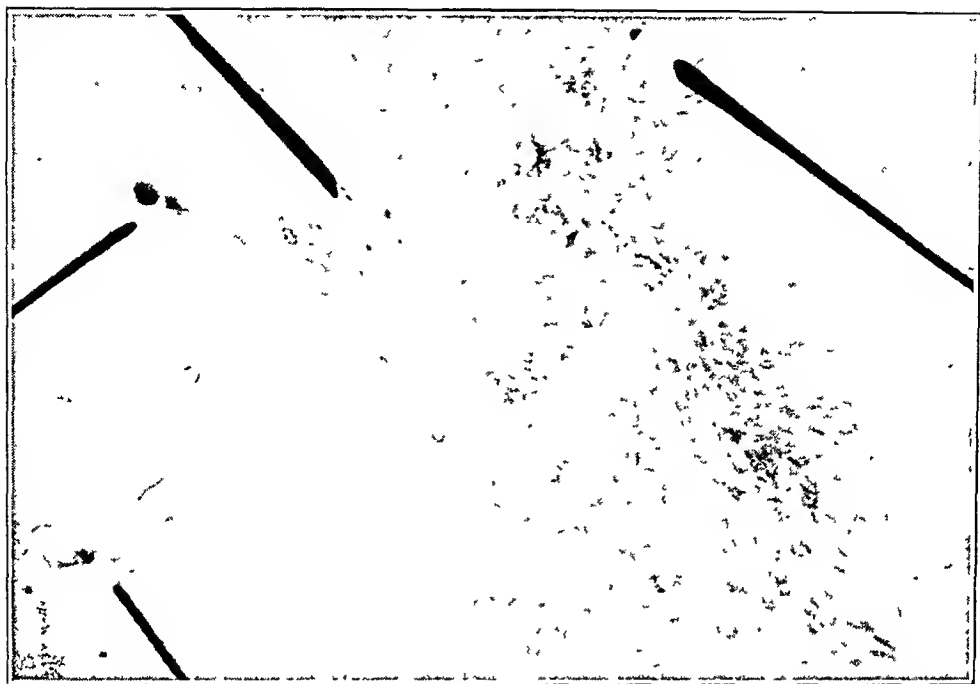


Fig. 5.—High power photomicrograph of tissue from the nasal passages of rabbit 4 (oscol drops).

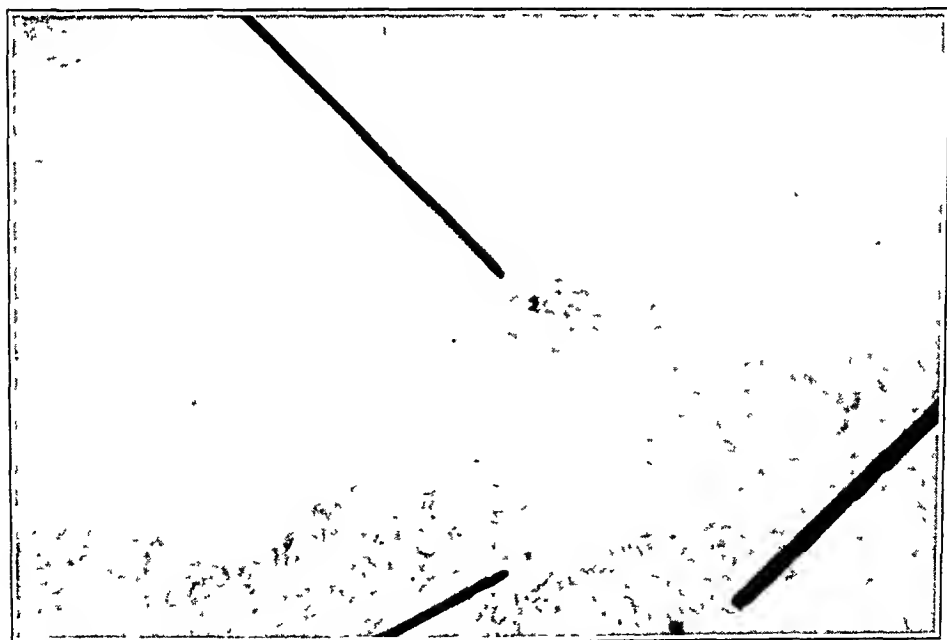


Fig. 6.—High power photomicrograph of tissue from the nasal passages of rabbit 5 (argyrol tampons).

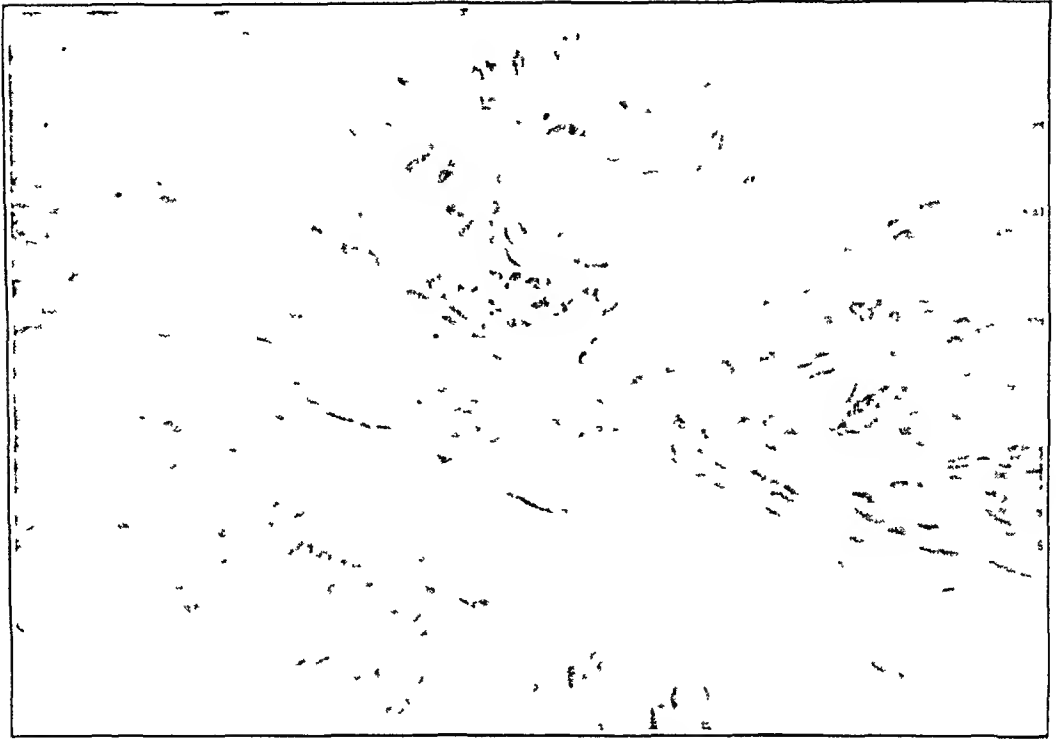


Fig. 7.—High power photomicrograph of tissue from the nasal passages of the control rabbit.

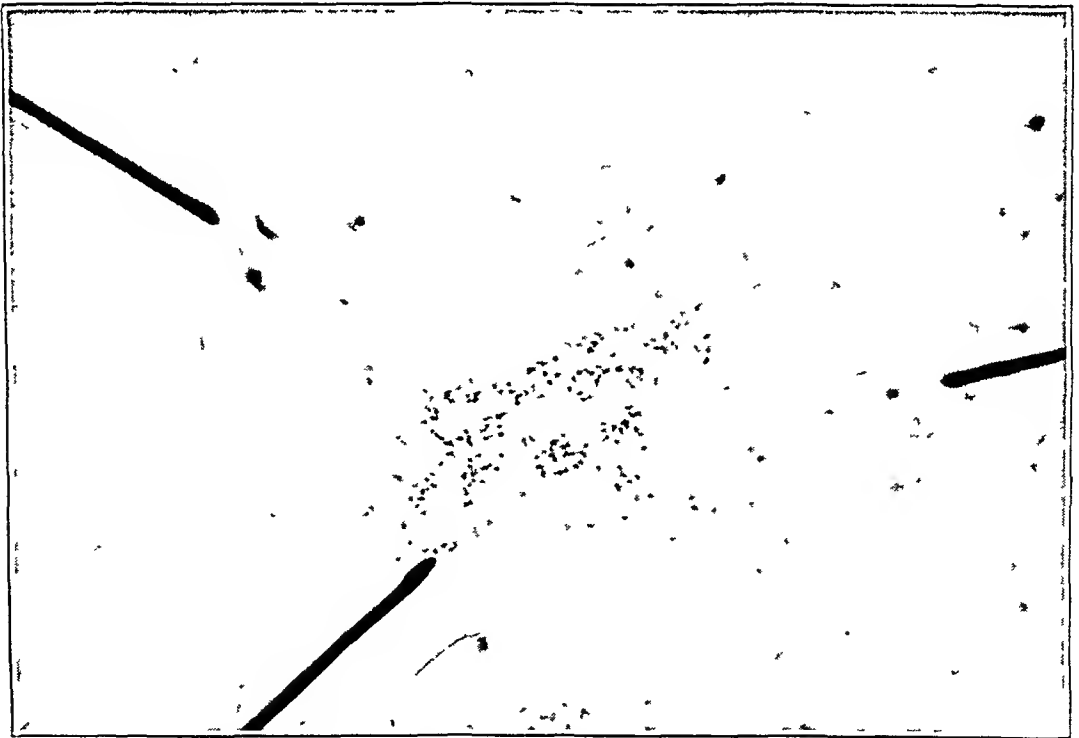


Fig. 8.—High power photomicrograph of tissue from the lungs of rabbit 2.



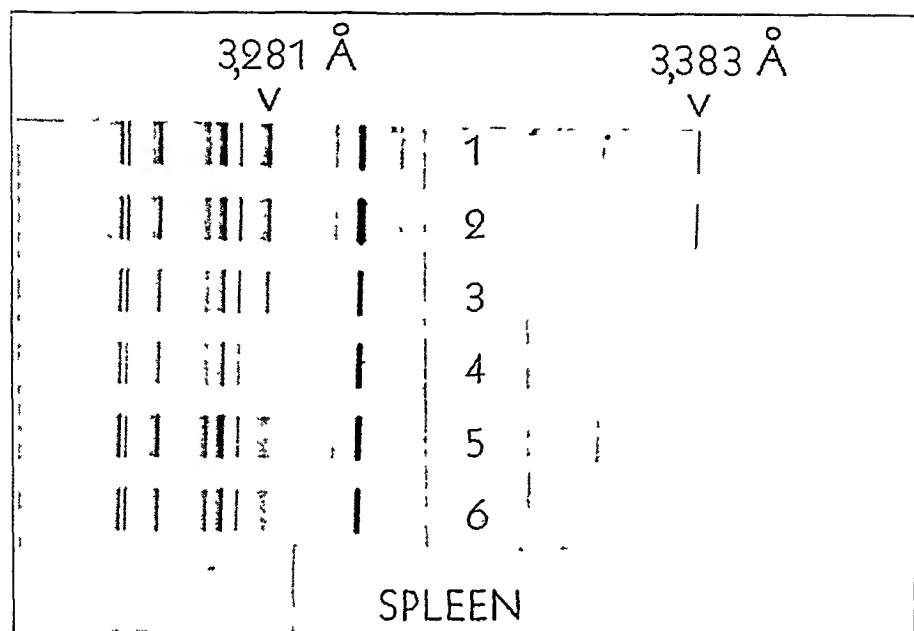


Fig. 9.—Portion of the biospectrographic film of the spleen from the 6 animals.



Fig. 10.—Portion of the biospectrographic film of the liver from the 6 animals

supported by the experimental work of Dworzak, cited by Gellhorn,<sup>5</sup> which showed that when uterine erosions and polyps are treated locally with silver nitrate, impregnation always occurs in two days.

To elucidate this point further and to determine if possible the rate and variation of absorption of different preparations commonly used in the nose, a series of experiments have been carried out on rabbits, the results of which are reported here.

Rabbit 1 had nasal instillations three times daily of a 10 per cent solution of argyrol (a brand of mild protein silver).

Rabbit 2 had nasal instillations three times daily of a 10 per cent solution of argental (a colloidal silver bromide preparation).

Rabbit 3 had nasal instillations three times daily of a 10 per cent solution of neo-silvol (a colloidal silver iodide preparation).

Rabbit 4 had nasal instillations three times daily of a 10 per cent solution of oscol (a colloidal silver preparation).

#### *Summary of Determinations of Silver on Rabbits by Spectrograph*

	Animal Number	Content in Milligrams per Hundred Grams of Tissue				
		Spleen, Mg.	Liver, Mg.	Kidney, Mg.	Skin, Mg.	Fur, Mg.
Argyrol, 10%.....	1	0.15	2.0	0.8	0.06	2.3
Argental, 10%.....	2	0.12	1.0	0.12	Not done	0.3
Neo-silvol, 10%.....	3	0.03	2.5	0.05	0.05	1.5
Oscol, 10%.....	4	0.02	0.04	0.02	0.02	0.2
Argyrol, 10%, tampons.....	5	0.02	0.18	0.05	0.02	0.3
Control.....	6	0.02	0.02	0.02	0.02	0.1

Rabbit 5 had cotton tampons of a 10 per cent solution of argyrol (mild protein silver), Dowling packs, in each side of the nose three times a week for two hours at a time.

Rabbit 6 was a control.

At intervals of two, four, six and eight weeks, tissue from the nasal passages of the experimental animals was removed for biopsy. This was sectioned and stained with 1 per cent aqueous solution of safranin. The two week series did not show deposits of silver. The four week series showed a trace in 1 or 2 sections. The six and eight week series showed silver in every specimen examined.

Figures 2 to 6 are photomicrographs of high power magnification of the tissues taken for biopsy. In each of them deposits of silver are visible in the form of grayish black granules or clumps. All of them were made after six weeks' use of the medication, and they are typical of what is seen throughout the slides. Similar observations were made on the sections of tissue made after eight weeks, the only section in which silver did not appear being from rabbit 6, the control.

Figure 7 is a photomicrograph under the same high power magnification of tissue from this control animal.

After six weeks, rabbit 2 (argental drops) died of interstitial pneumonitis, edema and collapse.

Figure 8 is a high power magnification of tissue from the lungs showing scattered deposits of silver in great quantity.

After eight weeks the remaining animals were killed by air embolism, and biospectrometric studies were made to determine the silver content of the liver, kidney, spleen, skin and fur of each animal.

Figure 9 is a portion of the biospectrographic film of the spleen from the 6 animals. A silver line occurs at 3,281 angstrom units, indicated by the caret on the left. It will be noted that band spectrums not of silver appear in many films at 3,280 angstrom units; these can be distinguished from bands representing silver by the sharpness of the silver line. A second silver line appears at 3,383 angstrom units, marked by the caret on the right.

Figure 10 shows the same lines for the liver tissue. It will be noted that in none of these slides is there a measurable silver line for rabbit 6, the control.

Biospectrographic studies of the kidney tissue, the skin and the fur resulted in the same general findings.

A summary of these findings is presented in the table, comparing the various animals and likewise the various tissues examined. Again it will be noted that the control animal has a minimal amount of silver except in the fur, which might well have been contaminated, particularly since the animals after death were inadvertently placed all in one box before being dissected.

#### COMMENT

Conscientious observers in the field of otolaryngology can no longer doubt the occurrence of generalized argyria caused by intranasal silver medications, especially in view of the 100 per cent increase in such cases reported during a recent five years. A persistent indifferent attitude to this on the part of otolaryngologists might be condoned if it were possible through the use of such medications to achieve beneficial results for the patient which could not be achieved otherwise, but quite the contrary is the case. Hilding, Proetz,<sup>8</sup> Negus and others, through their commendable experimental studies, have brought enlightenment as to the physiology of the nasal mucous membranes, and they have proved the importance of normal ciliary action. The work of Lierle and Moore<sup>9</sup> and of Proetz<sup>8</sup> showed that mild protein silver affects the ciliary beat adversely. In addition, there is an immediate mechanical interference with the highly important streaming of the mucous blanket, caused by the clumping of the drug over the surface. Since the infectious process is beneath the epithelium, it is doubtful that any antiseptic value possessed by colloidal solutions can compensate for their mechanical disadvantages. The same opinion was expressed by Walsh and Cannon<sup>10</sup> as a result of their investigations, which further showed that neither neo-silvol nor argyrol (10 per cent) had any bactericidal effect whatsoever on bronchiectatic pus after forty-four hours, despite the claims of the manufacturers.

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9. Lierle, D. M., and Moore, P. M.: Effects of Drugs on Ciliary Activity of Mucosa of the Upper Respiratory Tract, *Arch. Otolaryng.* **19**:55-65 (Jan.) 1934.

10. Walsh, T. E., and Cannon, P. R.: The Problem of Intranasal Medication. *Ann. Otol., Rhin. & Laryng.* **47**:579-607, 1938.

Walsh and Cannon found, moreover, that all their rabbits treated intranasally with 5 per cent argyrol and neo-silvol showed changes in the lungs, such as occurred in rabbit 2, of the present series, consisting of edema, necrosis, desquamation of septal cells and bronchopneumonic lesions. These changes were more marked when the animal in question had the snuffles. This gives one pause to think of the pulmonary lesions occurring especially in infants and children who have had similar nose drops for a preceding cold in the head.

When to these findings is added the real danger of the production of argyrosis, it would seem that a clear case against the use of the various silver preparations intranasally had been established and that they should be supplanted generally by the use of weak ephedrine or neosynephrin in an isotonic solution as a vehicle, since these have been proved when so used to have no deleterious effect on the lung tissue or on the action of the cilia and at the same time to achieve the only possible beneficial result, i. e., vasoconstriction and relief of congestion. It seems to be a duty also to disprove the advertised statements that "the argyrol tampon and the argyrol spray have become standard practice," and that there is "perfect safety in the use of 25-50 per cent applications and 10-25 per cent solutions at home." There has come to my attention only one preparation, namely, solargentum (a brand of mild protein silver), which carries on its label the following warning: "Caution: The prolonged use of any silver preparation may produce irremediable discoloration of the skin or mucous membrane (argyria)." Such printed warnings should be made mandatory to discourage self medication with silver salts over protracted periods, since this practice too often is the forerunner of argyria.

#### SUMMARY AND CONCLUSIONS

The generalized pigmentation of argyria is permanent; therefore, its only reasonable treatment is prevention.

Generalized argyria is apt to result from the photochemical action of light when the body carries silver equal to 8 Gm. of silver arsphenamine.

Silver in the usual intranasal medication is absorbed by the nasal membranes and distributed throughout the body.

Absorption of silver is experimentally demonstrable after six weeks of regular medication and in some instances after four weeks. In this study, its presence was proved by microscopic examination of the nasal tissues and by biospectrometric examination of several of the internal organs.

Widespread generalized deposits of silver were demonstrated throughout the tissue of the lungs of an experimental animal which

died from bronchopneumonic lesions as the result of the use of intra-nasal medication containing silver.

The use of silver-containing nasal medication over even a few weeks is dangerous and accomplishes nothing that cannot be accomplished safely and more efficiently by other means.

Measures should be taken to see that the public is warned of the danger of the production of argyria by long-continued self medication with silver preparations. All such preparations intended for use on mucous membranes should carry a warning statement on their labels.

Dr. Roy W. Hammack, pathologist, sectioned, stained and examined the tissues. Dr. Albert L. Chaney, biochemist, carried out the biospectrographic studies. Mr. Russell Stimson, of the firm of Heimann, Monroe and Jones, made the photographs.

2007 Wilshire Boulevard.

### ABSTRACT OF DISCUSSION

DR. GORDON F. HARKNESS, Davenport, Iowa: The internal administration of silver nitrate, though formerly the greatest cause of argyria, has been relegated to a minor place through the discontinuance of such medication.

My bibliography of sixty-five articles since 1931 reveals an even greater danger from the local application of true silver colloids or of silver salts in combination with protective colloids. Many families include these silver preparations in the "family medical cabinet" but are unaware of the dire consequences from prolonged self medication.

For a long time in our practice my associates and I have had "nonrefillable" on every such prescription.

To epitomize, a certain concentration of silver, largely intercellular, together with exposure to light, natural or artificial, seems essential to the condition recognized as argyria of the skin. That it can occur by direct absorption through mucous membranes has been established. The absorption of silver nitrate or lactate can be understood. The absorption of colloidal medicaments through local applications brings one into the realm of colloidal chemistry, which is beyond the ken of most otolaryngologists. While the physical overloading of the tissues is an important link, certain not well understood chemical alterations are essential to the clinical picture. This applies first to the absorption of colloids through animal membranes. The splitting of free silver ions at the site of application and their distribution in a soluble form, followed by the intercellular deposition in the form of an insoluble silver salt, may take place long before the clinical recognition of the condition.

Biospectroscopic examination will reveal the amount of silver retained in the tissues before any objective signs are apparent.

Clinical proof of argyria without clinical symptoms has recently come to my attention.

A woman now 47 received in 1927 one hundred capsules of silver nitrate or some silver-containing compound for so-called stomach trouble. Since that time she has not received medication with silver. Not until 1932, five years after medication, was the bluish gray tinge of her skin first noted. Since that time it has been constant and progressive. This, to my mind, clinically substantiates the presence of argyria of the tissues for a long time without clinical manifestations.

Many people who have argyria of the tissues for a long time without clinical manifestations are potential candidates for the recognizable type of the condition.

It seems that the insoluble silver salt most likely to produce this condition is silver chloride.

Whether it is the excess of chlorides in the body fluids, the  $p_H$  of body tissues, an idiosyncrasy or a sensitivity that precipitates the condition, no one has satisfactorily explained.

Silver chloride, being white, can be deposited without clinical evidence. Its oxidation, after it has become sensitive to light, with color changes, is a slow but progressive process.

Effect of treatment, except in small areas, is practically nil.

Until more is definitely known of the chemical alterations, the relief of the condition lies in the prevention, the avoidance of the indiscriminate use of silver preparations, the therapeutic efficacy of which has been largely exaggerated.

# INTERSTITIAL EMPHYSEMA OF THE LUNG WITH SPONTANEOUS PNEUMOTHORAX AND SUBCUTANEOUS EMPHYSEMA

DEMONSTRATION OF AIR IN THE SEPTUMS OF A HUMAN LUNG

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AND

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Pneumothorax with subcutaneous and mediastinal emphysema has long been known to occur in association with increased intrapulmonary pressure. Obstructive lesions of the larynx, trachea and bronchi are not infrequently accompanied by these conditions, which may become evident after tracheotomy.

Mediastinal and subcutaneous emphysema, with or without pneumothorax, may occur also in otherwise healthy persons who do not present any evidence of increased intrapulmonary pressure.

These conditions, occurring singly or simultaneously, have been recently brought to the attention of the members of the medical profession by Hamman,<sup>1</sup> McGuire and Bean<sup>2</sup> and Graebner.<sup>3</sup>

The pathogenesis of pneumothorax with mediastinal and subcutaneous emphysema was never explained satisfactorily with the aid of post-mortem examinations, as no definite rupture of the lung and parietal pleura was demonstrated in the majority of necropsies. The pathogenesis of these conditions was, therefore, until recently a matter of conjecture.

Bullowa<sup>4</sup> described subcutaneous emphysema without pneumothorax occurring in association with epidemic influenza. He suggested that

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From the Diphtheria Service and from the Pathologic Laboratories of the Willard Parker Hospital.

Presented in part at a meeting of the Section of Otolaryngology of the New York Academy of Medicine, April 19, 1939.

1. Hamman, L.: Spontaneous Mediastinal Emphysema, *Bull. Johns Hopkins Hosp.* **64**:1, 1939.

2. McGuire, J., and Bean, W. B.: Spontaneous Interstitial Emphysema of the Lung, *Am. J. M. Sc.* **197**:502, 1939.

3. Graebner, H.: Pneumopericardium and Pneumomediastinum in Cases of Acute Obstructive Laryngitis, *Arch. Otolaryng.* **29**:446 (March) 1939.

4. Bullowa, J. G. M.: Tissue Emphysema in Influenza, *M. Rec.* **95**:346, 1919.

rupture of the alveoli in those parts of the lung which were free from pneumonia and were overdistended by inspired air was responsible for the subcutaneous emphysema.

Macklin<sup>5</sup> presented an experimental explanation of the events leading to mediastinal emphysema, pneumothorax and subcutaneous emphysema in overdistention of the lungs. By overinflating the lungs of cats until pneumothorax developed, he succeeded in showing that the air from the distended alveoli entered the potential spaces of the perivascular sheaths in the interlobular septums. From these perivascular spaces the air traveled along the blood vessels to the mediastinum, spreading from there to the mediastinal pleura, to the subcutaneous tissues of the neck and to the retroperitoneal tissues. Minute ruptures in the blebs of the mediastinal pleura resulted in pneumothorax. Macklin could demonstrate this route of the air by filling the bronchial tree of the collapsed lung with fixing fluid until the lung was redistended to approximately the normal volume. This opened not only the collapsed alveoli but the septal spaces containing air. Microscopic sections from lungs treated in this manner showed air in the perivascular sheaths.

Graebner,<sup>3</sup> in reporting 5 cases of mediastinal emphysema associated with obstructive laryngitis, stated the opinion that escape of the air into the mediastinum takes place by the route suggested by Macklin.

Hamman,<sup>1</sup> in describing cases of mediastinal emphysema in normal adults, some of whom had associated pneumothorax, also accepted Macklin's explanation of the mechanism.

While sections from lungs of experimental animals showed the spread of air from the alveoli into the septum, this mechanism of pneumothorax has not been demonstrated in histologic sections from human lungs.

A case of diphtheria with obstruction of the respiratory tubes by membrane observed at this hospital afforded, apparently, the first opportunity to observe this mechanism in man.

#### REPORT OF A CASE

W. B., a white boy aged 2½ years, was admitted to the Willard Parker Hospital on Dec. 26, 1938, at 7 p. m. The child had been transferred from another hospital in the city.

*Past History.*—The child had undergone tracheotomy for a foreign body in the larynx in July 1937, at the age of 1 year. After the operation he had bronchopneumonia and empyema due to *Streptococcus haemolyticus*. The latter condition cleared up with intercostal drainage.

In July 1938 the child again had empyema due to *Str. haemolyticus* and *Staphylococcus albus*. He recovered after a thoracotomy.

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5. Macklin, C. C.: Pneumothorax with Massive Collapse from Experimental Local Over-Inflation of Lung Substance, *Canad. M. A. J.* **36**:414, 1937.



There was a questionable history of injections of toxoid. No Schick test had been performed. There was no history of contagious diseases.

*Present Illness.*—This began six days before the child's admission to the hospital from which he was transferred, when he had an infection of the upper respiratory tract, was lethargic and had a temperature of 103 F. He improved until the day of admission, when he became drowsy, vomited twice, was prostrated and had labored respirations. The temperature was 99.6 F., and cyanosis was noted. Culture of material taken from the throat three days before admission failed to reveal Klebs-Loeffler bacilli.

On admission to one of the hospitals in New York city on December 25, the patient was cyanotic. The respirations were rapid, with marked retractions. The temperature was 101.8 F.; the respiratory rate, 70 and the pulse rate, 130. While material for culture was being taken from the throat, the patient ceased to breathe; an emergency tracheotomy through the old tracheotomy scar was performed, and the child was resuscitated. Six thousand units of diphtheria antitoxin was given intramuscularly on admission. Culture of material from the throat gave negative results for diphtheria bacilli. On the following day 12,000 units of diphtheria antitoxin was given, one half of which was given intravenously and the rest intramuscularly. At one time during this day the patient became cyanotic, and a plug of membrane was removed from the tracheotomy tube. A culture of material from this yielded diphtheria bacilli, and he was transferred to the Willard Parker Hospital, to the service of Dr. Arthur S. Wilson.

On admission, on December 26, the child was moribund. He appeared very pale, with marked cyanosis of the nail beds; slight suprasternal retractions were evident. Emergency treatment was instituted immediately. The tracheotomy tube was removed; a laryngoscope was introduced, and suction of the larynx and trachea was done with a metal tracheal catheter. This procedure resulted in the removal of a large amount of thick white-gray membrane, including a tracheal cast. The larger bronchi were also treated by suction. The patient was given stimulants, oxygen by catheter and dextrose intravenously. These measures gave relief. Further examination at this time revealed a white-gray membrane on both tonsils, the uvula and the posterior pharyngeal wall. Cultures of material from these membranes showed the presence of virulent Klebs-Loeffler bacilli. Examination of the heart revealed sounds of poor quality, with a rapid rate, no arrhythmia and no murmurs. Examination of the lungs showed slight dulness over the left side of the chest anteriorly and posteriorly. The breath sounds came through fairly well over the right side of the chest but were diminished over the left. The liver was palpable 5 cm. below the costal margin. The temperature was 101.6 F., the respiratory rate 66 and the pulse rate 110. A diagnosis of laryngo-tracheobronchial diphtheria involving the tonsils, uvula and pharynx was made.

Further treatment at this time consisted in administration of 40,000 units of diphtheria antitoxin, one half of which was given intravenously and the rest intramuscularly. The tracheotomy tube was reinserted, and the child was given symptomatic and supportive treatment.

On the following day, at 9 a. m., the child appeared somewhat improved, but still acutely ill. Examination of the lungs revealed the breath sounds to be coming through well in both pulmonary fields. The color was good. The respiratory rate was 58, and the temperature, 101 F. The heart sounds were improved; no murmurs were heard, and the rate was 156. The liver was still enlarged. The membrane was still present on the tonsils, uvula and pharyngeal wall. Roentgen examination of the lungs at this time revealed no abnormality. No pneumothorax was present.

At 11:45 a. m. on December 28 the child began to have labored respirations, and suction at the bedside with a soft rubber catheter through the tracheotomy tube was of no avail. A laryngoscope was then introduced, and the larynx, trachea and bronchi were aspirated, with removal of many large pieces of white-gray membrane. Relief followed immediately. Examination of the lungs after this procedure revealed the breath sounds to be coming through well in both fields.

At 6:50 p. m. the same day the patient became very pale and ceased to breathe. Artificial respiration, stimulants, oxygen and intravenous injections of dextrose were given, and the patient was resuscitated. Aspiration was again performed, with removal of large pieces of membrane.

At 8:45 p. m. the child again became very pale; labored respirations were evident. Subcutaneous emphysema of the left side of the neck and the left anterior part of the wall of the chest was noted. Examination of the lungs at this time revealed a mediastinal shift to the right, with hyperresonance and diminished breath sounds on the left side. A diagnosis of pneumothorax on the left side was made. Aspiration of the larynx, trachea and bronchi was of no avail. A needle was placed in the left pleural space; a catheter attached to the hub of the needle was placed under water, and a large amount of air was drawn off. Owing to the extreme restlessness of the patient and the difficulty of maintaining the needle in place, this treatment was discontinued. The child had two mild convulsions and became more dyspneic and restless. He died at 11:48 p. m.

*Necropsy.*—Necropsy was performed eleven hours after death. The body was well developed and well nourished. A low tracheotomy incision, 2 cm. long, ending 1 cm. above the suprasternal notch, was present in the midline. The edges of the wound were thick and fibrotic. There was subcutaneous emphysema of the left side of the neck and of the left lateral abdominal wall subcostally. An old thoracotomy scar was present in the seventh intercostal space, in the right posterior axillary line.

The necropsy incision was limited to a downward prolongation for 5 cm. of the tracheotomy wound.

The edges of the wound were firmly adherent to the underlying tissues; the thyroid gland was divided during the tracheotomy.

Water was poured into the lower angle of the cutaneous incision, and both pleurae were punctured under water. Puncture of the left pleura resulted in a considerable escape of air bubbles; no air escaped from the right pleura.

The mediastinum could not be visualized, owing to the limitations of the incision. When the thoracic organs were removed, no blebs of air were seen over the thymus.

The right lung was entirely adherent to the parietal pleura over all its aspects; it was fairly well aerated except for several firm areas suggestive of early pneumonia.

The left upper lobe was partially adherent to the chest wall anteriorly and posteriorly; the lower lobe was adherent posteriorly. The adhesions were moderately strong, and apparently not recent. Parts of the lung were atelectatic, while several areas were firm and apparently bronchopneumonic. The rest of the lung was air holding. Edematous fluid appeared from the cut surface of the lung on pressure. The bronchioles contained a mucoid exudate.

The mucosa of the larger bronchi and of the trachea was rough, but no membrane was present. Some shreds of membrane were adherent to the congested laryngeal mucosa. A sheet of old scar tissue extended from the upper end of the tracheotomy wound to the vocal cords, without causing obstruction. The tonsils could not be reached through the low incision.

No air blebs were present over the pericardium. The parietal pericardium was entirely adherent to the visceral leaflet. Pleuropericardial adhesions were present on both sides. The heart weighed 95 Gm.

The liver and spleen were slightly enlarged and anemic. The adrenal glands were normal. The kidneys were slightly congested.

Microscopic Examination of the Lungs: Areas of emphysema, of edema, of intra-alveolar hemorrhage and of bronchopneumonia were present in both lungs.

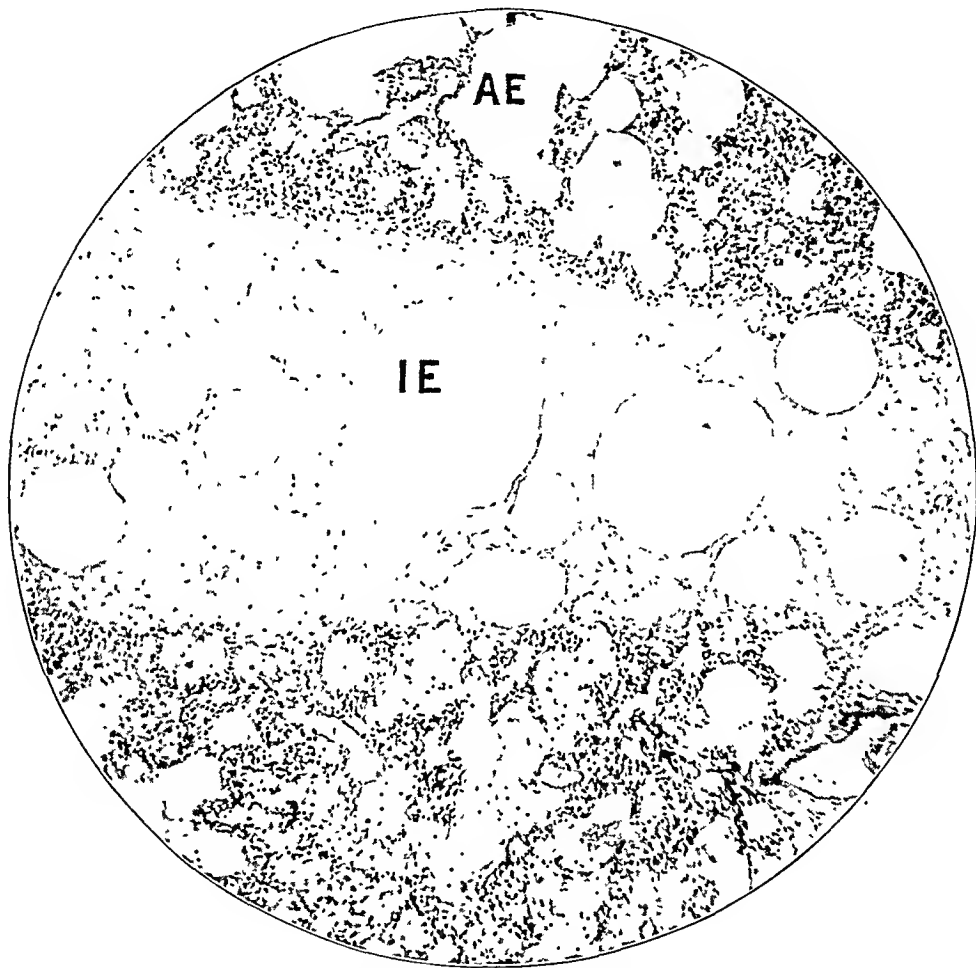


Fig. 1.—Air in the interlobular septum, giving it a “Swiss cheese” appearance. The septum is wide and edematous. *AE*, alveolar emphysema; *IE*, interstitial emphysema. Hematoxylin and eosin.  $\times 50$ .

Large parts of the left lung showed areas of atelectasis. Sections of two blocks of tissue from the left lung showed wide, edematous interlobular septums, with small hemorrhages. Large, round empty spaces, apparently bubbles of air which had escaped from the adjacent alveoli, were present in the septums, giving them a “Swiss cheese” appearance (fig. 1). A number of empty spaces were lined with flat cells resembling endothelium. In a section from one of the blocks some of the air spaces were partly filled with coagulated protein (fig. 2). The round spaces containing air were therefore identified as distended lymphatics.

Many small bronchi were collapsed. Some of the medium-sized bronchi showed congestion of the wall and desquamation of the epithelium and contained shreds of fibrinous membrane. No air-holding spaces were seen in the interstitial tissue in sections from the blocks taken at the root of the lung.

Toxic Klebs-Loeffler bacilli were recovered from the culture of heart's blood taken post mortem. It was impossible to determine whether the bacteremia was present during life or whether the bacilli entered the heart's blood from the adjacent organs after death.

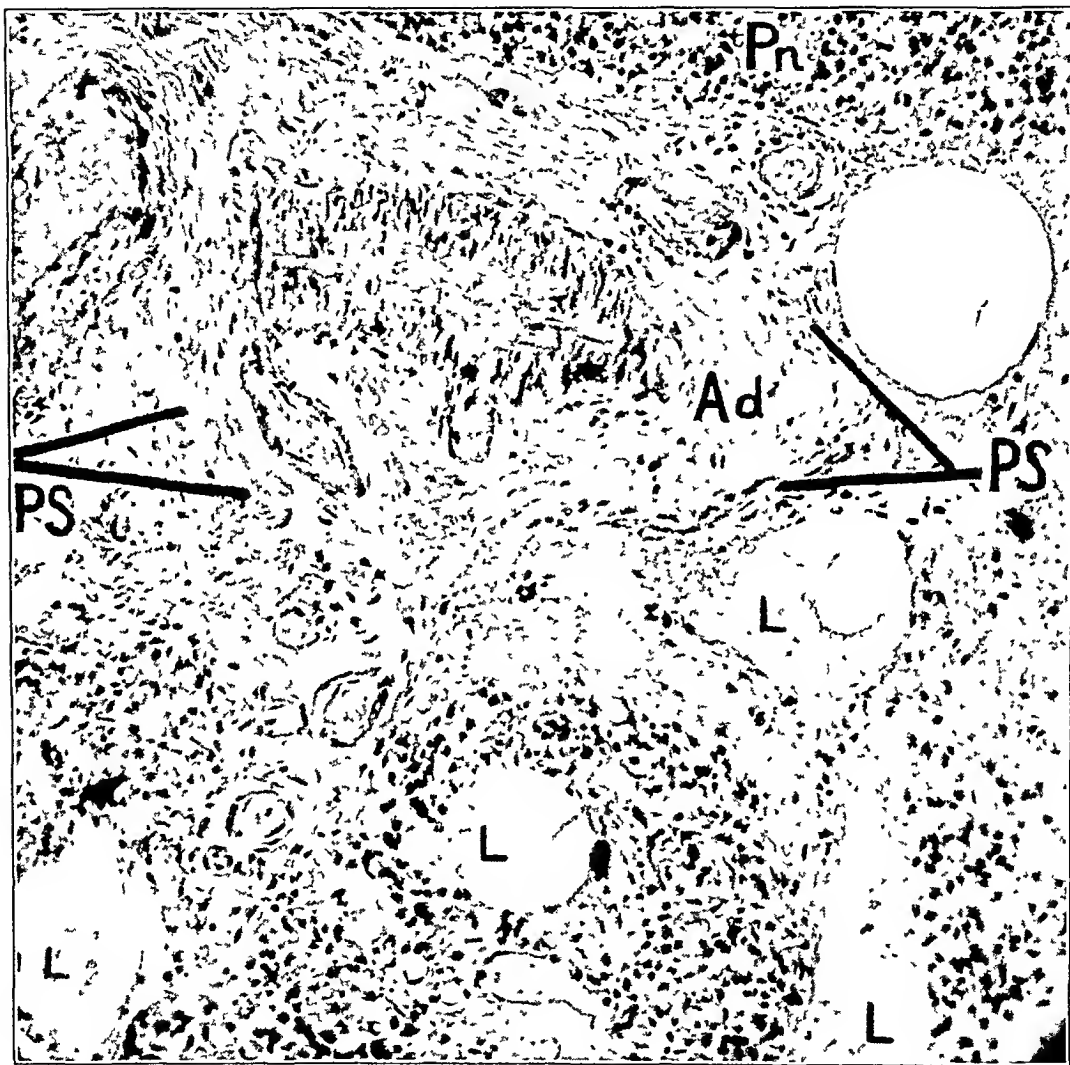


Fig. 2.—Location of air outside the perivascular sheaths. *PS*, perivascular sheath; *Ad*, adventitia; *L*, lymphatics, some of which are partly filled with air; *Pn*, pneumonia. Hematoxylin and eosin.  $\times 170$ .

#### COMMENT

The case presented was one of interstitial emphysema of the lung in a patient with diphtheria complicated by spontaneous pneumothorax and subcutaneous emphysema.

To our knowledge, no other cases are on record in which interstitial emphysema of the lung has been demonstrated in histologic sections of human lungs in cases of spontaneous pneumothorax. The demonstration

of air in the septums in histologic preparations was possible only because the lung did not fully collapse after the pneumothorax occurred, being held in partial expansion by pleural adhesions and by bronchopneumonia. The partial expansion kept open the alveoli not affected by pneumonia and the septal spaces containing air. These conditions closely approximated those produced by Macklin by reexpansion of the collapsed lungs of cats.

As there was no mediastinal emphysema in this case, the derivation of the subcutaneous emphysema and of the pneumothorax from the interstitial emphysema of the lung may require a somewhat different

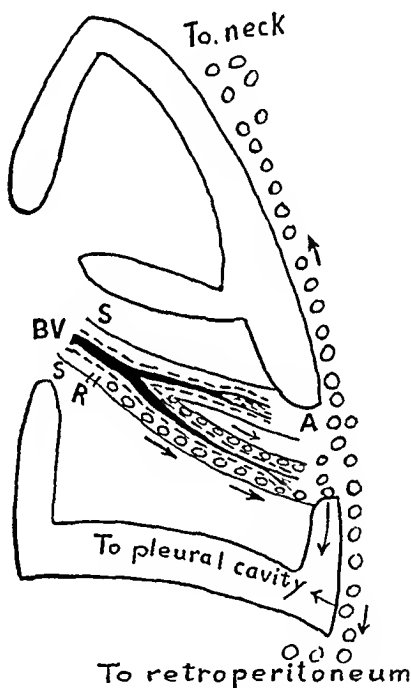


Fig. 3.—Diagram illustrating the mechanism of pneumothorax and subcutaneous emphysema in the presence of pleural adhesions and in the absence of mediastinal emphysema. *S-S*, septum; *BV*, blood vessel; dotted line, potential perivascular sheath; *A*, adhesion; *R*, alveolar rupture.

explanation from that given by Macklin. In our case the air in the septums was seen not in the perivascular sheaths but in septal lymphatics outside these sheaths. It is probable that from the septal lymphatics the air traveled not to the hilus but to the periphery of the lung, i. e., to the lymph channels of the septal adhesions, and escaped from there into the pleural cavity and into the retropleural connective tissue. The air could also have found its way into the pleura through the rupture of retropleural blebs (fig. 3). From the retropleural tissues the air could readily have spread into the subcutaneous tissues of the neck and the

abdomen. This short route, from ruptured alveoli through pleural adhesions into the subcutaneous tissue, has been mentioned by several authors (von Bergmann;<sup>6</sup> Neffson and Bullowa<sup>7</sup>).

The rupture of the alveoli probably occurred in a part of the lung which was free from bronchopneumonia and which had been overinflated because of severe and prolonged interference with normal respiration by the diphtheritic membrane and because of vicarious emphysema.

The tracheotomy apparently had no bearing either on the pneumothorax or on the subcutaneous emphysema, as it was performed through an old tracheotomy scar and through the thyroid gland, which would hardly have permitted any aspiration of air into the surrounding tissues; besides, the pneumothorax occurred three days after the tracheotomy.

#### SUMMARY

A case is reported in which a patient with obstruction of the respiratory tubes by a diphtheritic membrane, not relieved by tracheotomy and late administration of antitoxin, had unilateral pneumothorax and subcutaneous emphysema without mediastinal emphysema. As the lung was not fully collapsed, because of bronchopneumonia and old pleural adhesions, microscopic sections revealed the interstitial emphysema of the septums, with air in the distended lymphatics.

The air in the septums probably traveled to the periphery of the lung and escaped through the pleural adhesions into the pleural cavity and into the subcutaneous tissue.

Dr. Arthur S. Wilson gave us permission to report this case.

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6. von Bergmann, G.: Das mediastinale Emphysem, in von Bergmann, G., and Stachelin, R.: *Handbuch der inneren Medizin*, Berlin, Julius Springer, 1928, vol. 2, pt. 1, p. 669.

7. Neffson, A. H., and Bullowa, J. G. M.: Influenza with Simultaneous Bilateral Spontaneous Pneumothorax and Subcutaneous Emphysema: Report of a Case, with Comment on the Mechanism of Production, *Arch. Otolaryng.* **28**:388 (Sept.) 1938.

# BENIGN TUMORS OF BRONCHI

WITH SPECIAL REFERENCE TO VASCULAR ADENOMA

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In the rapidly accumulating literature on benign bronchial tumors, one type stands out as deserving special consideration. Various designated as "bronchial adenoma," "adenomatous polyp" and "vascular adenoma," it is a type of growth which can now be fairly accurately identified histologically and recognized clinically. Being the most common, it deserves to be considered apart from the motley group of benign endobronchial tumors which have been thrown together under one heading in the literature.

Any bronchial growth if left untreated ultimately produces occlusion of a bronchus with resulting atelectasis, drowned lung and pulmonary suppuration. Earlier recognition, which is now occurring with increasing frequency, permits treatment before irreparable damage to the lungs has been done. Of the bronchial new growths the benign vascular adenomas appear to show the most constant clinical course. Study of the case histories in the literature bears this out.

Since publication of the opinion of Jackson and Jackson,<sup>1</sup> most of the benign bronchial tumors have been considered due to stagnation of purulent secretion and have been designated as "inflammatory tumors." Peroni,<sup>2</sup> on the basis of experimental work, likened them to hyperplastic and degenerative processes in the nose and larynx and preferred to designate them as "inflammatory polypi."

According to others, vascular adenomas appear to possess the characteristics of real blastomas. It is difficult to believe that they are primarily inflammatory in origin, because they are seldom found in cases of long-standing bronchiectasis and pulmonary abscess.

These tumors may exist for years without producing signs of obstruction, but by their tendency to cause a characteristic type of hemoptysis

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Presented as a candidate's thesis to the American Laryngological, Rhinological and Otological Society.

1. Jackson, C., and Jackson, C. L.: Benign Tumor of the Trachea and Bronchi, with Special Reference to Tumor-Like Formation of Inflammatory Origin, *J. A. M. A.* **99**:1747 (Nov. 19) 1932.

2. Peroni, A.: Inflammatory Tumors of Bronchi, *Arch. Otolaryng.* **19**:1 (Jan.) 1934.

they frequently may be diagnosed before the lung has been severely damaged. That this is true is shown by the experience of Wessler and Rabin,<sup>3</sup> who were able to make a correct diagnosis in 9 of 14 cases.

Pollak, Cohen and Gnassi<sup>4</sup> up to 1937 collected 104 recorded cases of primary benign tumor or inflammatory hyperplastic tumor-like formation of the bronchial tree, diagnosed at autopsy or by bronchoscopic biopsy. Almost half of these (51) were adenomas. Twenty-three, or 22 per cent, were included under "inflammatory hyperplastic growths"; among these were such formations as simple polyps, papillomas and granulomas. The rest formed a mixed group, consisting of fibromas, chondromas, lipomas, leiomyomas and lymphomas.

#### PATHOLOGIC DATA

Adenomas may represent a congenital anomaly (Fried<sup>5</sup>). This author stated that they originate from the cells lining the bronchial mucous glands; Wessler and Rabin expressed the belief that they more nearly resemble the cells lining the ducts of these glands. Fried affirmed that mucous glands are not found in bronchi less than 10 mm. in diameter. Adenomas are, accordingly, limited to the walls of the larger bronchi—an important fact which is borne out clinically.

Mallory<sup>6</sup> has advanced the opinion that histologically they more nearly resemble carcinoid tumors of the intestinal tract. He contended that, although of slow growth, they sometimes show a tendency to invade the bronchial wall and cannot be classified as exclusively benign. Womack and Graham<sup>7</sup> have recently contributed a new point of view, likening them to mixed tumors of the parotid gland, including their potentiality for malignant change. In addition to bronchoscopic observations they had the opportunity of studying the pathologic character of these tumors after lobectomy and pneumonectomy. They saw in them a resemblance to fetal lung tissue and stressed their many points of similarity to mixed tumors. This study is important because, as the investigators pointed out, few adenomas have been discovered at autopsy. Womack and Graham stated that many undergo malignant

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3. Wessler, H., and Rabin, C. B.: Benign Tumor of Bronchus, *Am. J. M. Sc.* **183**:164 (Feb.) 1932.

4. Pollak, B. S.; Cohen, S., and Gnassi, A. M.: Inflammatory Bronchial Tumors: Report of a Case and Review of the Literature, *Arch. Otolaryng.* **27**:426 (April) 1938.

5. Fried, B. M.: Adenoma of Bronchial Mucous Gland, *Arch. Otolaryng.* **20**:375 (Sept.) 1934.

6. Adenoma of the Bronchus, Cabot Case 24091, *New England J. Med.* **218**:390 (March 3) 1938.

7. Womack, N. A., and Graham, E. A.: Mixed Tumors of the Lung: So-Called Bronchial and Pulmonary Adenoma, *Arch. Path.* **26**:165 (July) 1938.



change, which makes impossible their postmortem differentiation from ordinary far advanced bronchogenic carcinoma. This represents a reversion to the belief held some years ago, when many adenomas were considered by pathologists to be adenocarcinoma. As Jackson and Konzelmann<sup>8</sup> pointed out, pathologists who have previously diagnosed certain growths as carcinomas now admit doubt as to the malignancy of the tumors, in view of survival of the patients for many years.

These tumors occur most commonly in women between 30 and 40 years of age; carcinomas are found four times as frequently in men between the ages of 40 and 60.

Benign tumors of the bronchi grow slowly and usually first encroach on the bronchial lumen in the form of a polypoid elevation beneath the mucosa. Later they become elongated and pyriform, their free ends projecting upward toward the trachea, this direction being imparted to them by the accompanying irritating cough. Many become pedunculated.

The body of the tumor is usually covered by a layer of bronchial epithelium which frequently shows squamous metaplasia. The epithelium rests on an intact basement membrane under which is a layer of loose connective tissue containing an abundant supply of dilated blood vessels. This is such a prominent finding that recently the tumors have been referred to as "vascular adenomas."<sup>9</sup> The main bodies of such tumors are composed of polyhedral cells with large round or oval reticular nuclei arranged either in acini or in solid columns. The cells rest on a definite basement membrane, are uniform and homogeneous in structure and staining qualities and usually lack mitotic figures. However, at times the cells extend deep to the cartilage plates of the bronchus, indicating the difficulties of completely eradicating the growth. The presence of abundant capillaries between the groups of tumor cells speaks against malignancy. Because the cells are not always arranged in glandlike formation (fig. 1) the term "adenoma" is unacceptable to some.

#### BRONCHOSCOPIC APPEARANCE

Through the bronchoscope an adenoma appears as a rather smooth, rounded, congested, cherry-like growth, frequently with blood vessels coursing underneath its epithelial covering. There is freedom of movement to the end of the bronchoscope, which is often not present in

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8. Jackson, C. L., and Konzelmann, F. W.: *Bronchoscopic Aspect of Bronchial Tumors, with Special Reference to So-Called Bronchial Adenoma*, J. Thoracic Surg. **6**:312 (Feb.) 1937.

9. Zamora, A. M., and Schuster, N. H.: *Vascular Adenoma of Bronchus*, J. Laryng. & Otol. **52**:337 (May) 1937.

malignant disease. Slight contact with the end of the bronchoscope or the suction tube is apt to release a brisk hemorrhage.

#### SYMPTOMS AND DIAGNOSIS

Clinically there is a typical latent period, during which cough may be absent, but hemoptysis in this stage is common and deserves separate consideration. Morlock and Pinchin<sup>10</sup> cited the case of a patient in whom hemoptysis was the sole symptom for over twenty years. In some women it may occur only during the menstrual period. It differs from

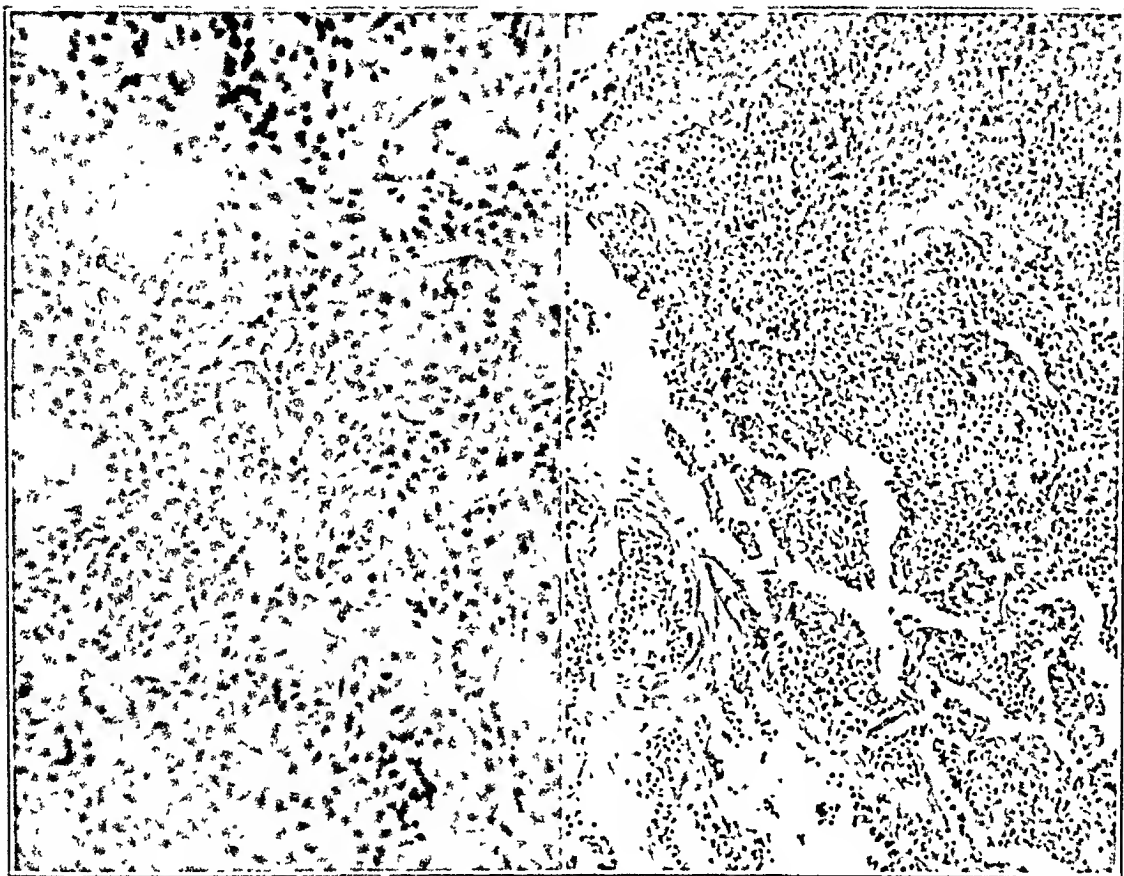


Fig. 1.—Low and high power photomicrographs of a specimen of tissue from a benign vascular adenoma.

the bleeding of parenchymal lesions of the lung in that it occurs suddenly, without warning, and may cease just as abruptly without appreciable further streaking. Coming from a large bronchus, its downward course impeded by the tumor mass, the blood is expectorated before it can collect in the smaller bronchi. Turner,<sup>11</sup> on the other hand, sug-

10. Morlock, H. V., and Pinchin, A. J. S.: Benign Neoplasms of Bronchus, with Records of Nine Cases, *Brit. M. J.* **2**:332 (Aug. 24) 1935.

11. Turner, P. A.: Benign Tumors of the Bronchus, with Especial Reference to Early Diagnosis: Two Case Reports, *Kentucky M. J.* **31**:423 (Sept.) 1933.

gested that these growths predispose to bronchospasm in the presence of sudden hemorrhage, thus preventing aspiration of the blood and explaining the sudden cessation of bleeding. He based his supposition on the fact that iodized poppyseed oil would not enter below the point of attachment of the tumor even in a case in which the lumen of the bronchus was not obliterated by the growth. In 1 of my patients iodized oil did fill the bronchi, outlining a few sacculations (figs. 2*B* and 2*C*).

There is frequently a history of preceding attacks of pneumonia, and it is fair to assume that many were attacks of pneumonitis following atelectasis from bronchostenosis. Because of their marked vascularity, adenomas are prone to undergo changes in size and shape, thus producing succeeding attacks of atelectasis. Ultimately, if they are unrecognized and untreated, drowned lung, bronchiectasis and pulmonary suppuration ensue. Infection has been known to spread to the pleura, producing effusion and empyema.

Soreness in the affected side of the chest is a common complaint.

The so-called asthmatoïd wheeze, an important sign of bronchial obstruction, which is best heard at the open mouth, may frequently be elicited. In many cases the condition has been confused with bronchial asthma because of the attacks of paroxysmal wheezing. When the tumors have long pedicles, patients may have extreme attacks of dyspnea on suddenly changing their position. When hemoptysis predominates, the condition is frequently mistakenly diagnosed as pulmonary tuberculosis.

In the early stages physical findings and roentgen evidence may be lacking. However, when the tumor has attained a size sufficient to occlude a bronchus and interfere with ventilation and drainage, symptoms and signs of atelectasis and pulmonary suppuration will soon become apparent.

#### ROENTGEN FINDINGS

Two roentgen signs which hitherto have not been stressed may be helpful in diagnosis. They cannot replace bronchoscopic observations as the final arbiter, but they may be used to advantage in stressing to both patient and physician the need for this examination. One deals with the changes found in "lung mapping" and the other with the so-called triangular shadow at the base of the lung. Careful study of films taken after filling of the bronchi with iodized poppyseed oil may reveal the outline of the tumor mass (figs. 2*B*, 2*C*, 3*A* and 3*B*) and may also indicate the lack of filling of the tributary portion of lung (fig. 3). The second sign, the "triangular shadow at the base of the lung," is sometimes demonstrable in the presence of atelectasis of a lower lobe. This finding, of course, obtains only when the tumor obstructs the entrance to a lower lobe. Experience has shown that this is actually the most common site of these growths. Rosenblum and

Klein<sup>12</sup> have referred to this recently in reporting the case of a boy 11 years old in whom they found an adenomatous polyp in the right main bronchus, producing atelectasis and bronchiectasis of the right lower lobe. In 1 of my cases, when this triangular shadow was noted on the roentgenogram it was at first thought to be a distortion of the mediastinum. Since I became acquainted with the work of Anspach,<sup>13</sup> who showed that in children it is produced by an atelectatic lower lobe and is a precursor of bronchiectasis, its interpretation has become clearer. In none of the 50 children studied by Anspach was the atelectasis caused by an obstructing bronchial tumor; in the majority of instances it was due to infection and in 3 cases to a foreign body. *A* and *B* of figure 2 clearly show this triangular basal shadow as distinct from the right border of the heart.

#### TREATMENT

In comparison to what is known of the pathologic and clinical aspects, information regarding the exact management of these tumors is meager. The physician encountering his first case is often at sea as to the best type of procedure.

From a study of the reported cases it is found that five types of treatment are available: (1) removal through the bronchoscope; (2) electrocoagulation; (3) radium treatment; (4) roentgen treatment, and (5) partial or total pneumonectomy.

*Bronchoscopic Removal.*—With such vascular tumors as adenomas this appears to be a difficult and dangerous procedure. Physicians who have observed the release of an alarming flow of blood by mere contact of the suction tube with the tumor have no great inclination to use biting forceps. Although usually the hemorrhage may be controlled by suction and by sponging with epinephrine, sufficient blood may have reached the pulmonary parenchyma to produce alarming postoperative pneumonitis (case 1).

Artificial pneumothorax instituted and maintained prior to instrumentation may obviate this danger. I adopted this measure in 1 instance, with gratifying results. Subsequent treatment after failure to maintain the pneumothorax (because of the patient's lack of cooperation) again produced postoperative reaction. The method was used with the idea that compression of the lung would prevent blood from reaching the alveoli, thus minimizing the incidence of parenchymal infections. The use of pneumothorax for benign tumors was sug-

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12. Rosenblum, P., and Klein, R. I.: Adenomatous Polyp of Right Main Bronchus Producing Atelectasis, *J. Pediat.* 7:791 (Dec.) 1935.

13. Anspach, W. E.: Atelectasis and Bronchiectasis in Children: Study of Fifty Cases Presenting Triangular Shadow of Base of Lung, *Am. J. Dis. Child.* 47:1011 (May) 1934.

gested to me by a recommendation made by Pressman and Emery<sup>14</sup> in the treatment of bronchial carcinomas. These authors stated that they have found it extremely valuable prior to the intrabronchial application of a basket containing radium needles.

*Electrocoagulation or Surgical Diathermy.*—This measure has recently been stressed by Kernan,<sup>15</sup> who has contributed some important details. It should be tried only with the region under local anesthesia, an attempt being made to preserve the cough reflex. Kernan has designed a special bronchoscope with a separate channel for the active electrode, which allows for better vision. He has expressed his preference for a bead-shaped rather than a pointed tip on account of the risk of penetrating the bronchial wall. Surgical diathermy is apt to cause a greater shrinking of the growth than is seen immediately after a treatment, because the vitality of the tissue away from the point of contact is also affected. The treatment should not be too strenuous, because of the danger of scarring and stenosis. This was impressed on me by observation of the end result in case 4. In this case, after various types of treatment at another clinic during the past ten years, the tumor had apparently receded but the orifice of the right main bronchus was left no larger than a pinhead.

Removing the major portion of the growth by the use of a biting forceps and following this immediately by coagulation is also dangerous, on account of the risk of penetration. Coagulation treatments may be repeated every two weeks. Secondary hemorrhage as late as two weeks after coagulation is possible. It occurred in 1 of my cases in an alarming manner.

*Radium Treatment.*—This may be applied by direct implantation of radon seeds into the tumor mass or by placing adjacent to it a tube containing seeds or needles.

Radon seeds of gold or platinum may be inserted and left in place for the desired number of days, or they may be implanted with the idea of allowing them to remain permanently. When so placed they seemingly find firm anchorage and remain embedded. In case 3 radon seeds were implanted ten years prior to the time of writing and are still to be observed roentgenographically at the site of the tumor. One cannot help wondering what deleterious foreign body effects would result if the seeds were lost in the smaller bronchioles.

Belsey,<sup>6</sup> citing the plan adopted at the Brompton Hospital, London, England, stated that twelve seeds, each containing 1.25 millicuries, are distributed within the jacket of a canalized tubular container, which is

14. Pressman, J. J., and Emery, C. K.: New Method of Radium Application in Cancer of Bronchus, *Ann. Otol., Rhin. & Laryng.* **46**:314 (June) 1937.

15. Kernan, J. D.: Electrocoagulation in Bronchogenic Conditions, *Arch. Phys. Therapy* **19**:38 (Jan.) 1938.

placed alongside the tumor through the bronchoscope and maintained in position by a spring for seven days and then removed. Pressman and Emery have adopted a similar plan for treating bronchial carcinoma, inserting a "bird cage" containing radium needles around the growth. The cage is left in place from thirty to sixty-five hours.

*High Voltage Roentgen Therapy.*—This method has been used in some of the cases cited in the literature, but in most of them it appears to have been utilized only as an adjunct to other forms of treatment.

*Surgical Extirpation.*—Removal of the affected lobe or lung by lobectomy or pneumonectomy is destined to find increasing favor, especially in cases in which the tumors have been long unrecognized and untreated and irreparable pulmonary damage has been done. With the advances in pulmonary surgery this form of treatment may also play an increasingly popular role even in cases in which the pathologic process is not so far advanced.

#### REPORT OF CASES

CASE 1.—R. B., a woman aged 30, was admitted to St. Joseph's Hospital May 18, 1937, under the care of Dr. G. H. Curiman. She complained of cough, bloody expectoration, wheezing and pain in the right side of her chest. She had been told by one physician that she had tuberculosis and by another that she had asthma. She had had two attacks of pneumonia in childhood. For the past six years she had been short of breath. A roentgenogram of the lungs showed increased peribronchial shadows and a triangular area of density at the base of the right lung (fig. 2A). The presumptive diagnoses were asthmatic bronchitis and bronchiectasis. I was asked to instil iodized poppyseed oil for "lung mapping." On questioning of the patient the possibility of bronchial tumor suggested itself and I advised bronchoscopic examination.

*Bronchoscopic Examination.*—A tumor mass the size of a navy bean was revealed. It was red and vascular, with a sessile attachment to the medial bronchial wall; it nearly obstructed the entrance to the right lower lobe bronchus. When the growth was touched with the suction tube a profuse hemorrhage occurred. Biopsy specimens were taken, and 10 cc. of iodized poppyseed oil was instilled into the right main bronchus. Histologic examination showed a vascular polypoid growth with no evidence of malignancy.

*Bronchoscopic Treatment (June 30).*—Attempts were made to encircle the tumor with a cold wire snare and also with a diathermy loop, without success. Several pieces were removed with a punch forceps. This was followed by electrocoagulation. Bleeding was brisk. Histologic examination of the material removed at this sitting showed "large, distended vascular channels." The diagnosis was angioma of the bronchial mucosa. On the third day there were a rise in temperature to 104 F. and signs of consolidation in the lower lobe of the right lung. On July 15 the patient had a severe hemorrhage.

*Artificial Pneumothorax.*—Pneumothorax was decided on in order to collapse the right lung prior to the next bronchoscopic treatment, in an attempt to minimize the dangers from hemorrhage. This was done and another bronchoscopic treatment was given on Aug. 7, 1937, at which time the tumor was again coagulated. Little reaction followed, and the patient left the hospital on the fifth day.

On September 2 electrocoagulation was repeated. The lung had been allowed to reexpand because the patient had refused further refills. On the following day there was a rise in temperature to 102 F., which lasted for two weeks. A roentgenogram of the chest showed an area of density at the base of the right lung, possibly with fluid. The patient finally recovered but was advised to have radon implantations at a later bronchoscopic treatment in view of the severe bleeding and aspiration pneumonia which had followed the preceding treatments.

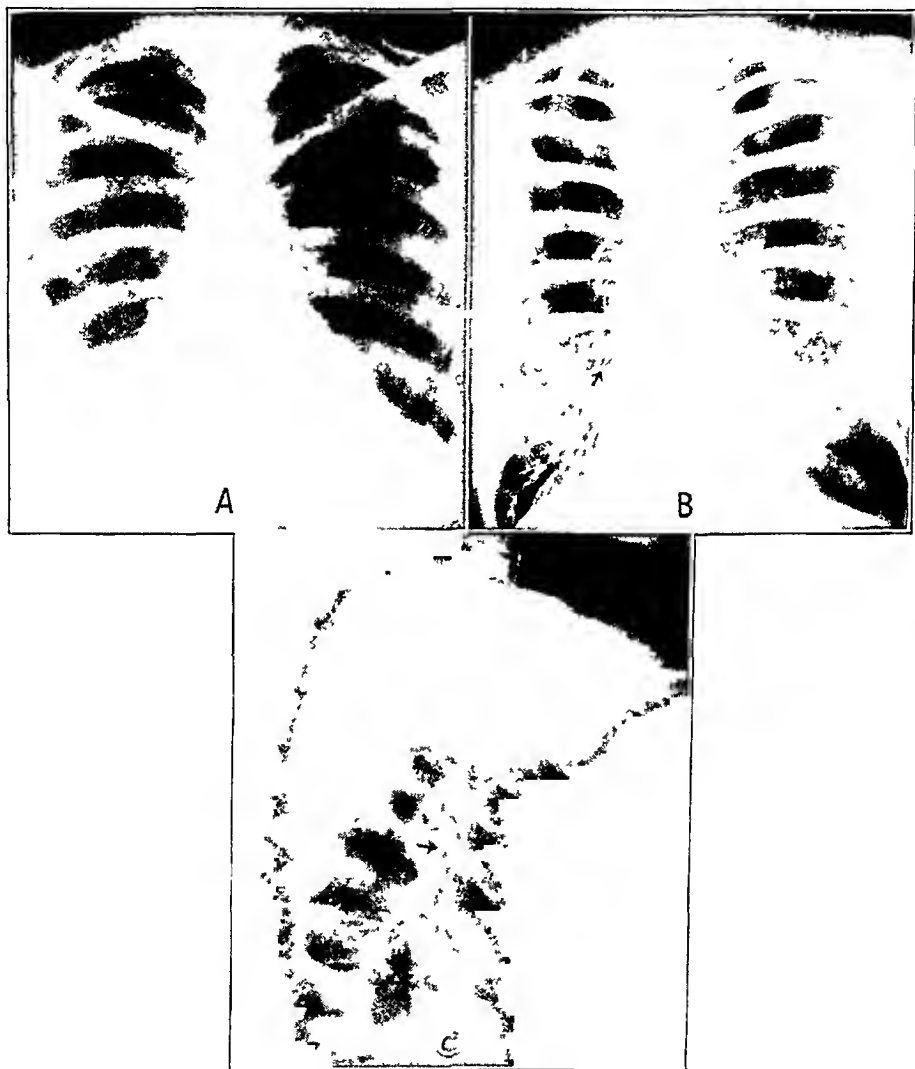


Fig. 2 (case 1).—*A*, roentgenogram of the chest, showing a triangular shadow at the base of the right lung. The right border of the heart is distinctly seen and is separate from this shadow, which indicates atelectasis of the lower lobe. *B*, roentgenogram taken after filling of the bronchi with iodized poppyseed oil, showing the outline of the tumor and the triangular shadow. The arrow points to the probable outline of the tumor. *C*, lateral roentgenogram taken after injection of iodized oil, showing the outline of the tumor and a few sacculations in the lower lobe of the right lung, indicative of early bronchiectasis. The arrow points to the probable outline of the tumor.

CASE 2.—R. H., a man aged 29, first entered St. Joseph's Hospital under the care of Dr. C. A. Shepard on Oct. 19, 1935, with a diagnosis of pneumonitis of the lower lobe of the left lung. He recovered, but during the succeeding year he continued to raise varying quantities of bright red blood at intervals. Physical and roentgen examinations repeatedly gave negative results. Two bronchoscopic examinations had been made by another bronchoscopist, but no definite tumor mass or bleeding area was seen. After an unusually severe hemorrhage, pneumothorax was induced and was maintained for several months.

*Bronchoscopic Examination.*—On Feb. 4, 1938, a large mass was revealed in the left main bronchus, close to the orifice of the branch to the lower lobe. The tumor extended along the posterolateral wall of the left main bronchus, filling more than half of its lumen. A moderate amount of bleeding followed the removal of a biopsy specimen, which was reported to show "angioma of the bronchial wall."

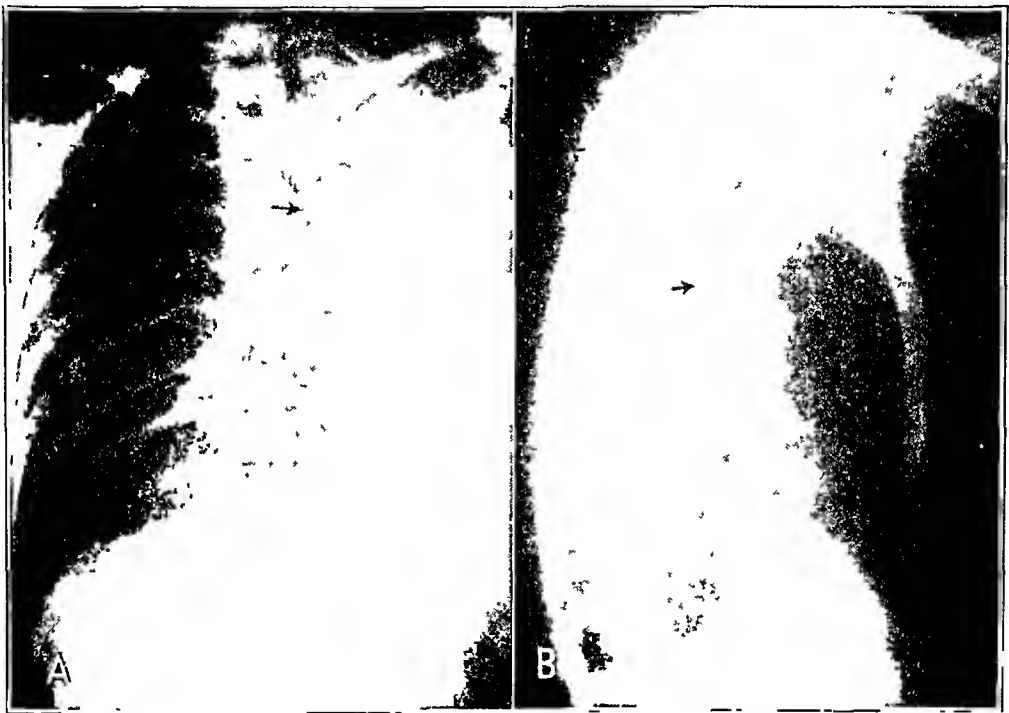


Fig. 3 (case 3).—*A*, roentgenogram of the chest after filling of the bronchi with iodized poppyseed oil, showing the outline of the tumor in the region of the orifice of the left main bronchus. The left lung is atelectatic, and the trachea is pulled over to the left. *B*, lateral roentgenogram taken after filling of the bronchi with iodized oil, showing the outline of the tumor (indicated by arrow) at the bifurcation of the trachea.

Electrocoagulation was then applied. On March 7 three radon seeds were implanted in the tumor mass. A roentgenogram of the chest taken several weeks later showed the radon seeds in place. The patient then left the city, apparently in good health. In a letter seven months later he reported an increase in the severity of his symptoms. He had had numerous bronchoscopic treatments without improvement. He added that he would soon undergo a lobectomy, which had been recommended in an eastern clinic.

CASE 3.—A G., a woman aged 42, entered the Denver General Hospital Feb. 20, 1937. She had been in the ward for patients with tuberculosis for the past



two months. She had suffered repeated sudden hemorrhages during the past four years. The roentgen rays revealed atelectasis of the left lung, the trachea being markedly deviated to the left. After filling with iodized poppyseed oil, the outline of a tumor mass blocking the entrance to the left main bronchus could be distinctly made out. The iodized oil did not enter the left lung (fig. 3).

*Bronchoscopic Examination.*—On March 18 Dr. C. H. Darrow made a bronchoscopic examination, which showed a lobulated tumor mass 1.5 to 2 cm. in diameter, located at the carina and filling the left main bronchus. The tumor extended slightly into the right main bronchus and bled easily. Apparently it was not pedunculated. The report on the biopsy specimen was "low grade adenocarcinoma." This was followed by a course of roentgen treatments of a calculated dosage of  $1\frac{1}{2}$  erythema skin doses. A roentgenogram taken April 30 was thought to show about one-third reduction in the size of the tumor. On May 6, three gold radon seeds containing 6 millicuries were implanted in the tumor mass. On May 21, two additional radon seeds were inserted. When last heard from the patient had had no further hemorrhages.

Reexamination of the biopsy specimen revealed the structure and arrangement of the cells to be typical of nonmalignant vascular adenoma (fig. 1).

CASE 4.—E. S., a woman aged 37, came to the outpatient department of the National Jewish Hospital with the following history: After an attack of pneumonia in 1927 she was left with a dull, aching pain in the right side of her chest and an irritating cough. There was no bleeding. In March 1930 a smooth tumor almost occluding the right main bronchus and attached to the right side of the trachea just above the level of the bifurcation was found at a bronchoscopic examination made in New York city. The report of the biopsy specimen was "adenomatous hyperplasia of mucous glands, possibly carcinoma."

In September 1936 a diagnosis of adenoma (cylindroma) of the bronchus was made. The patient stated that radon seeds had been implanted ten years previously. Repeated cauterizations had been done until June 1937, followed by a course of twelve roentgen treatments. A roentgenogram of the chest taken on Oct. 20, 1938 showed two radon seeds in the region of the orifice of the right main bronchus.

*Bronchoscopic Examination.*—On April 15 the lumen of the right main bronchus was shown to be narrowed to the size of a pinhead. This was dilated with Jackson bougies ranging in caliber up to no. 18 F. The patient reported definite improvement for about four months, but at the time of writing she has noticed an increase in wheezing and shortness of breath for one month.

#### SUMMARY AND CONCLUSIONS

Three cases of benign bronchial tumor are added to the literature. A fourth case, in which the patient was treated elsewhere and is now under my care on account of fibrotic bronchial stenosis, is also cited.

The majority of benign bronchial tumors fall into the category of benign adenoma, which should be regarded as an entity. Although the histologic diagnosis is now better established, pathologists still disagree on many important points, including the degree of malignancy of such a tumor. The history of a characteristic type of hemoptysis, often

over a period of years, together with the physical signs and bronchoscopic findings, should receive equal consideration with biopsy reports in diagnosing this type of growth.

Bronchographic examination may help in outlining the tumor, but it should never replace accurate bronchoscopic examination.

When the growth obstructs a lower lobe, the demonstration of a triangular shadow at the base of the lung, indicating atelectasis, may afford a clue by pointing to the need for a diagnostic bronchoscopic procedure.

Artificial pneumothorax should be considered prior to bronchoscopic removal or destruction by electrocoagulation because of its value in reducing the incidence of posthemorrhagic aspiration pneumonia.

Treatment by bronchoscopic methods has resulted in many apparent cures or arrests and should be tried first. When this is unsuccessful, lobectomy and pneumonectomy offer an increasingly favorable outlook.

Case 3 is reviewed by permission of Dr. C. H. Darrow.

# DIPLACUSIS: A LOCALIZING SYMPTOM OF DISEASE OF THE ORGAN OF CORTI

THEORETIC CONSIDERATIONS, CLINICAL OBSERVATIONS AND  
PRACTICAL APPLICATION

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The finding of diplacusis in a case of deafness is a valuable diagnostic aid in localizing the pathologic condition, since diplacusis can be caused only by a lesion of the organ of Corti.

This statement is based on theoretic considerations, which I shall discuss, and on clinical observations, which I shall describe. If it is true, some practical applications follow for the diagnosis and treatment of certain cases of deafness and of Ménière's syndrome.

## INTRODUCTORY OBSERVATIONS

*Definition.*—Diplacusis is the hearing of one sound as two. There are three varieties of diplacusis: Diplacusis binauralis echotica, in which a sound is heard a fraction of a second later by one ear than by the other, as a distinct echo, is comparatively rare. I have observed it but once (case 8). Diplacusis monauralis dysharmonica, in which a pure tone is heard by the affected ear as a double tone of two different pitches, also is a rare symptom which I have seen but once (case 4). Diplacusis binauralis dysharmonica, in which the same sound is heard at a different pitch by the two ears, is rather frequent in aural disease. It is this type which is referred to generally in the literature, and unless otherwise specified in this paper, as diplacusis.

*Testing for Diplacusis.*—Disharmonic diplacusis is more common than one would infer from the literature. Musicians in whom diplacusis develops are usually annoyed by it and complain of it. The great majority of patients with diplacusis, however, are not aware of it until they are specifically tested for it. The ordinary hearing tests, including the audiogram, will not elicit the symptom. Diplacusis must be specifically tested for.

The test for diplacusis is made with tuning forks, and a complete series by octaves, from 64 to 2048 vibrations should be employed, since diplacusis rarely affects the entire tonal scale to an equal degree and

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may be limited to a part of it. In testing for diplacusis it is of the utmost importance that the patient hear the fork with equal loudness in each ear, for otherwise many patients will confuse loudness with pitch. The vibrating tuning fork is held alternately in front of each ear, the distance being regulated so that the patient hears the tone equally loud in the two ears. He is asked whether he hears the same tone in the two ears. When true diplacusis is present the patient states that he hears an entirely different sound in one ear from that which he hears in the other, the pitch being definitely higher or lower. With this difference in pitch, may occur an alteration in the quality of the sound also, so that it is rasping, harsh, unpleasant or even painful to the diseased ear as contrasted to the pleasant musical tone heard by the normal ear. It is helpful to have the patient hum the note that he hears in each ear. An occasional patient who is unmusical will be unable to distinguish pitch but will still recognize that the quality of the sound is entirely different in his two ears.

*Theoretic Considerations.*—Many diverse explanations of diplacusis have been offered. Because it is sometimes seen in cases of otitis media, many authors, including Politzer, Gradenigo and Jacobsen, expressed the belief that alterations in the sound-conducting apparatus accounted for diplacusis in at least some cases. In 1920 Schilling<sup>1</sup> made the first positive statement that diplacusis is always due to structural alterations in the vibrating elements of Corti's organ. In 1923 Shambaugh and Knudsen,<sup>2</sup> unaware of Schilling's publication, reached the same conclusion on the basis of a clinical study of 10 cases of diplacusis, stating that the alteration is such that a segment of the membrane which normally vibrates to a certain tone subsequently vibrates to a tone of a higher or lower pitch. In 1935 I<sup>3</sup> described a syndrome consisting of low tone nerve deafness, diplacusis and attacks of vertigo. I pointed out that on theoretic considerations and in view of recent work on the physiology of hearing which substantiated the theory of selective localization of tone in the cochlea, diplacusis could only be caused by a distortion of the vibrating membrane in the organ of Corti and could not be caused by any lesion in the conducting mechanism, the eighth nerve or the central acoustic tracts (Fig. 1).

In 1937 Proetz<sup>4</sup> experienced temporary diplacusis in his own ear. From his observations in his own case he concluded that diplacusis is due to a lesion of the vibrating membrane in the organ of Corti.

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1. Schilling, R.: Ueber musikalisches Falschhören, Arch. f. Ohren-, Nasen- u. Kehlkopf. **105**:65, 1920.

2. Shambaugh, G. E., and Knudsen, V. O.: Report of an Investigation of Ten Cases of Diplacusis, Tr. Am. Otol. Soc. **16**:397, 1923.

3. Shambaugh, G. E., Jr.: Syndrome of Diplacusis and Nerve Deafness for Low Tones, Arch. Otolaryng. **21**:694 (June) 1935.

4. Proetz, A. W.: Diplacusis, Binauralis Dysharmonica, Ann. Otol., Rhin. & Laryng. **46**:119, 1937.

In the absence of pathologic proof, which up to the present time is lacking, reliance must be placed on clinical evidence to prove or disprove the theoretic statement that diplacusis is due to a lesion of the organ of Corti.

### CLINICAL OBSERVATIONS

The clinical observations are based on a series of 45 patients with diplacusis observed during the past few years. These patients were all seen in routine office practice in which the tuning fork tests for diplacusis are included as part of the routine hearing tests. The 45 patients with diplacusis had the following aural conditions: Thirty-three had primary nerve deafness; 5 had suppurative otitis media, 3 acute and 2 chronic; 3 had had a Lempert operation for fistulization of the labyrinth for otosclerosis; 2 had otosclerosis; 1 had catarrhal otitis media, and 1 had otherwise normal hearing.

#### OTHERWISE NORMAL HEARING WITH DIPLACUSIS (ONE CASE)

CASE 1.—Mrs. R. L. D., aged 41, complained of roaring in the right ear for five months and hoarseness off and on for several years. The tuning forks were

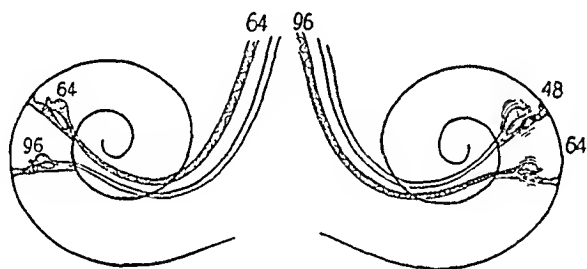


Fig. 1.—In the normal ear the note of a fork of 64 double vibrations stimulates its special portion of the organ of Corti and its set of nerve fibers. In the affected ear the vibrating membrane has been altered so that the area which previously responded to the fork of 96 double vibrations now responds to that of 64 double vibrations, the tone of the latter fork being heard in the brain as one of 96 double vibrations, the result being diplacusis.

heard equally well in both ears but slightly higher pitched and with an uncomfortable reverberation in the right ear. The right vocal cord was edematous in the middle third. The basal metabolic rate was —18 per cent. On administration of thyroid the tinnitus and diplacusis improved, and they had nearly disappeared when the patient moved away, six weeks later.

It is possible that in this case the diplacusis was due to edema of the vibrating membrane in the organ of Corti caused by thyroid deficiency. The patient is the only person I have seen with diplacusis and otherwise normal hearing.

#### CATARRHAL OTITIS MEDIA WITH DIPLACUSIS (ONE CASE)

CASE 2.—Mr. R. E. P., aged 61, complained of fulness and slight deafness in the right ear for two days, and his wife's voice sounded unpleasantly harsh in that

ear. Hearing tests showed a slight conduction defect in the right ear, chiefly for the 32 and 64 vibration forks, with diplacusis, these forks being heard at a higher pitch and sounding less musical in that ear. Inflation of the eustachian tube with a catheter relieved the fulness and improved the hearing but did not help the diplacusis, which did not clear up until several days later.

In this case the diplacusis was evidently not due to the tubal occlusion, since it was not relieved by inflation. There was probably coincident edema of the vibrating membrane in the cochlea.

#### OTOSCLEROSIS WITH DIPLACUSIS (TWO CASES)

CASE 3.—Mrs. L. Mc. M., aged 39, complained of progressive deafness for eighteen years. Her father had had progressive deafness. The drum membranes were normal, with a distinct pink glow from the right promontory. Hearing tests revealed a bilateral conduction defect, with diplacusis for the 2048 vibration fork, which was heard one and a half tones higher in the left ear than in the right. The

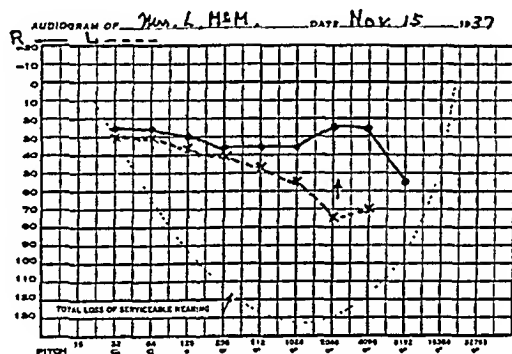


Fig 2 (case 3).—Otosclerosis with primary fixation of the stapes in both ears and secondary degeneration of the nerve in the left ear (evidenced by the loss of hearing for high tones); diplacusis for the 2048 frequency fork, which is heard  $1\frac{1}{2}$  tones higher pitched in the left ear.

diagnosis was otosclerosis with primary fixation of the stapes and secondary labyrinthine involvement on the left side as evidenced by the loss of hearing for high tones and the diplacusis (fig. 2).

CASE 4.—Mr. A. K. O., aged 35, was first seen by my father sixteen years ago, because of gradual impairment of hearing. Bilateral high tone nerve deafness was found, but because of a family history of deafness and a distinct pink glow from the promontories the diagnosis of probable primary labyrinthine otosclerosis was made. The nerve deafness slowly increased until eighteen months before the time of this report, when the loss of hearing was accelerated and the tuning fork tests began to show a conduction defect in addition to the nerve deafness, indicating beginning ankylosis of the stapes. At the time of writing, diplacusis has been present for nine years for the 2048 vibration fork, which is heard at a higher pitch in the right ear. A month ago monaural diplacusis for the 1024 vibration fork developed in the left ear, so that this fork is heard as a double tone in this one ear. The diagnosis is primary labyrinthine otosclerosis with secondary fixation of the stapes (fig. 3).

Diplacusis is unusual in otosclerosis. Both the patients clearly had labyrinthine involvement for the high tones, which the diplacusis affected, so that the diplacusis could be accounted for by a lesion of the vibrating membrane in the cochlea.

### POSTOPERATIVE DIPLACUSIS (THREE CASES)

CASE 5.—Mrs. B. P., aged 45, complained of progressive deafness for four years. The drum membranes were normal, and hearing tests showed a conduction defect. The Lempert fistulization for otosclerosis was carried out in July 1938. The operation was uneventful, with marked improvement in hearing on the table. The first day after operation there was second degree nystagmus, and the second day there was severe vertigo, nausea and vomiting. The tuning forks were heard in both ears, but diplacusis was present for the 512 to 4096 vibration forks, which were all heard at a higher pitch in the ear operated on. Two days later the diplacusis had spread to include also the 128 and 256 vibration forks. One month later the diplacusis was still present, but there was no reaction to the fistula test nor caloric response from the horizontal canal, and the hearing was not improved over the preoperative level.

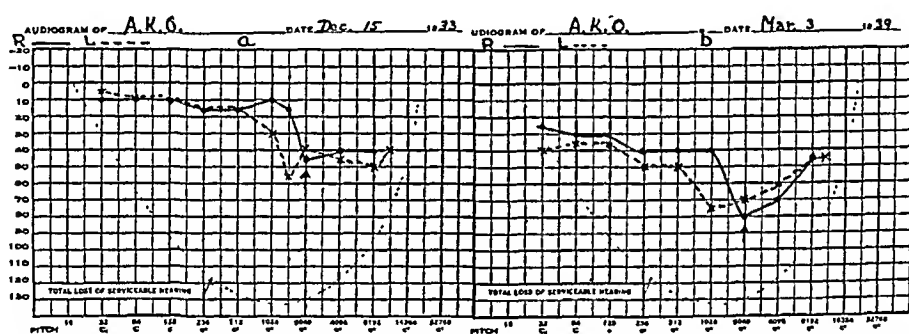


Fig. 3 (case 4).—Otosclerosis with primary nerve deafness (a), secondary fixation of the stapes developing fifteen years after onset (b); diplacusis for the 2048 frequency fork, which is heard at a higher pitch in the right ear.

This was clearly a case of postoperative serous labyrinthitis resulting in loss of function of the horizontal canal and involving the cochlea, as evidenced by the diplacusis, but not producing a dead labyrinth.

CASE 6.—Miss M. C., aged 28, complained of progressive deafness for twelve years. The drum membranes were normal, and the hearing tests were characteristic of conduction deafness. The Lempert fistulization for otosclerosis was carried out in July 1938. The membranous horizontal canal was ruptured, as evidenced by the empty appearance of the lumen when the bony canal was opened. There was immediate marked improvement in hearing, which lasted forty-eight hours without vertigo or nystagmus. Diplacusis for the two highest-pitched forks, 1024 and 2048 vibrations, was present on the second postoperative day, and a week later it had spread to involve all the forks, so that they were heard at a higher pitch in the ear operated on. At the time of writing the ruptured membranous canal has healed, as evidenced by a strongly positive reaction to the fistula test, which is active nine months after operation. The diplacusis has diminished until

only the 256 and 2048 vibration forks are heard at a slightly lower pitch in the ear operated on. The hearing is only slightly improved over the preoperative level (fig. 4).

It is significant that when the membranous labyrinth was ruptured diplacusis first developed for the tones which produce vibration in the part of the organ of Corti closest to the operative trauma, that is, for the high tones, and gradually spread to involve the low tones. The patient, incidentally, has absolute pitch, and she was able to report accurately the exact difference in pitch between the two ears.

CASE 7.—Mr. P. L. J., aged 41, complained of progressive deafness for fifteen years. The drum membranes were normal, and the hearing tests showed a conduction defect. The Lempert operation for otosclerosis was carried out in October 1938. The membranous horizontal canal was accidentally ruptured, as evidenced by the empty lumen of the bony canal and failure to respond to the fistula test on the table. A week later, however, the membranous canal had healed, and there was an active response to the fistula test, which is still present at the

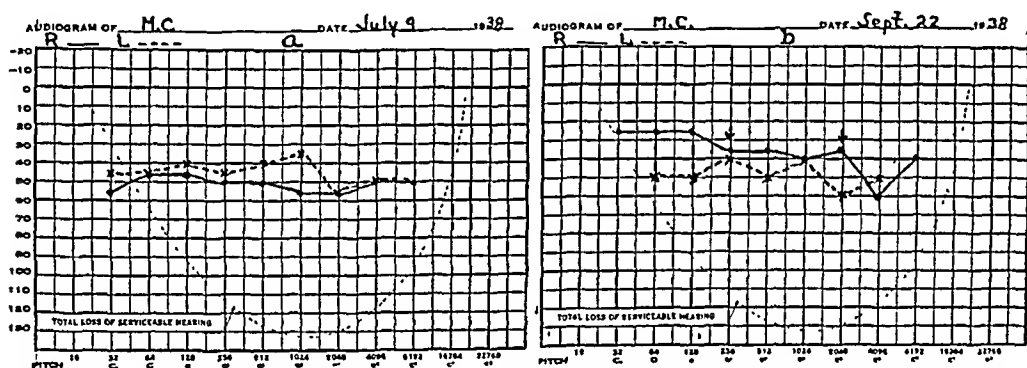


Fig. 4 (case 6).—Preoperative hearing in a case of otosclerosis with primary fixation of the stapes (a); hearing after fistulization of the labyrinth (right ear), diplacusis for the 256 and 2048 frequency forks, which are heard at a lower pitch in the ear operated on (b).

time of writing, seven months later. Diplacusis first appeared, nine days after operation, for the 1024 vibration fork, and two days later, for all the forks, which were heard at a higher pitch in the ear operated on. The diplacusis cleared up two months later. The hearing was not improved at any time over the preoperative level.

In 5 more patients with otosclerosis operated on by the Lempert procedure, the membranous labyrinth was not injured, and there was no postoperative serous labyrinthitis. In none of these 5 patients did diplacusis develop, indicating that diplacusis after the Lempert operation means a lesion of the membranous labyrinth involving the cochlea.

#### SUPPURATIVE OTITIS MEDIA WITH DIPLACUSIS (FIVE CASES)

CASE 8.—Miss C. F., aged 42, complained of severe earache on the left for two days, with vertigo, nausea, vomiting and ataxia for one day. She was found



to have acute suppurative otitis media with spontaneous nystagmus toward the affected ear, indicating serous labyrinthitis. Diplacusis for all the forks was present, all the forks being heard at a higher pitch in the affected ear. The otitis media lasted only a few days, and the labyrinthitis gradually subsided. A week after the onset echoic diplacusis appeared, sounds being heard a second later in the affected ear. Three weeks after onset the hearing was practically normal; the echoic diplacusis was gone, but the disharmonic diplacusis was still noticeable for the high tones, which were higher pitched, harsh and actually painful in the affected ear. (fig. 5).

CASE 9.—Mr. D. J., aged 16, complained of earache for four days, discharge for three days and vertigo, nausea and ataxia for two days. There was spontaneous

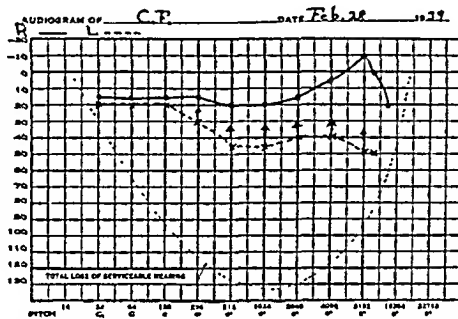


Fig. 5 (case 8).—Acute suppurative otitis media (left) with acute serous labyrinthitis and diplacusis, the 256, 512, 1024, 2048 and 4096 frequency forks being heard at a higher pitch in the left ear.

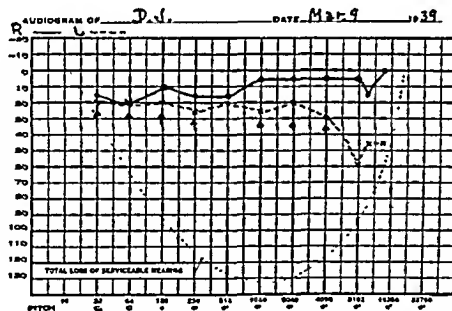


Fig. 6 (case 9).—Acute suppurative otitis media (left) with acute serous labyrinthitis and diplacusis, all forks being heard at a higher pitch in the left ear.

second degree nystagmus toward the affected ear, indicating acute serous labyrinthitis. Diplacusis was present for the 128 to 2048 vibration forks, which were heard at a higher pitch in that ear. The discharge lasted ten days; the diplacusis lasted a little longer but was gone a month later (fig. 6).

CASE 10.—Miss J. M. G., aged 57, complained of defective hearing following acute suppurative otitis media eight months before. The ear had discharged for only a few days, but dizziness and ataxia with profound deafness lasted three weeks. Since then the hearing had gradually improved. Music sounded disagreeable and out of tune, but this condition also was improving. Hearing tests revealed definite diplacusis for the low tones, which were heard at a higher pitch in the

affected ear. The patient was diagnosed as having had acute serous labyrinthitis with acute otitis media.

CASE 11.—Mrs. A. B. H., aged 31, complained of a chronic discharge from the ear for six years, with attacks of vertigo, ataxia and nausea for six weeks. Two weeks before when especially dizzy she noticed that the radio sounded harsh in the affected ear. She was found to have cholesteatoma. Hearing tests showed diplacusis for all the forks, which were heard at a higher pitch in the affected ear. A radical mastoidectomy resulted in a dry ear, no more attacks of dizziness and disappearance of the diplacusis. The diagnosis was mild serous labyrinthitis complicating cholesteatoma.

CASE 12.—Mrs. M. W., aged 43, presented a chronic discharge from the ear, with a central perforation. The audiogram showed a pronounced loss for the middle tones in this ear, and the tuning fork test for these tones showed diplacusis so that they were heard at a slightly higher pitch in the discharging ear (fig. 7).

In all 5 cases of suppurative otitis media with diplacusis there was definite evidence of labyrinthine involvement. Diplacusis is an unusual finding in otitis media. Its presence indicates serous labyrinthitis.

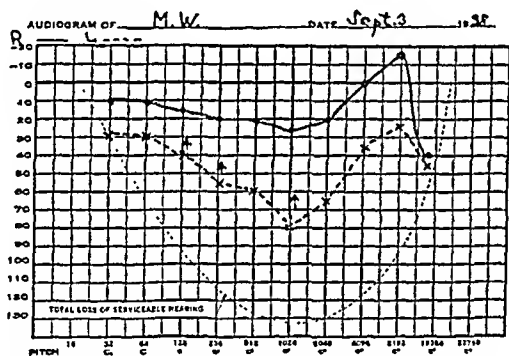


Fig. 7 (case 12).—Chronic suppurative otitis media (left) with labyrinthine deafness (evidenced by the pronounced depression of hearing) and diplacusis for the middle tones, the 128, 256 and 1024 frequency forks being heard at a higher pitch in the left ear.

#### PRIMARY PERCEPTION DEAFNESS WITH DIPLACUSIS (THIRTY-THREE CASES)

The great majority of the patients with diplacusis showed primary nerve deafness with nothing in the hearing tests or in the clinical examination to indicate an impairment of sound conduction. The 33 patients with this condition can be further classified etiologically as follows: 16 patients the cause of whose condition was undetermined, most of whom were seen but once; 2 patients whose deafness and diplacusis cleared up spontaneously; 2 patients in whom the onset was apoplectiform and suggested a hemorrhage into the labyrinth; 2 patients whose condition followed an acoustic trauma; 6 patients whose condition cleared up after removal of a focus of infection, and 5 patients whose

condition cleared up after removal of a specific food to which they were allergic.

### PRIMARY NERVE DEAFNESS AND DIPLACUSIS OF UNDETERMINED CAUSE (SIXTEEN CASES)

The nerve deafness was confined to one ear or was much greater in one ear in most of the patients the cause of whose condition was undetermined. Moreover the loss of hearing usually involved the low as well as the high tones and was sometimes more pronounced for the former, so that these patients characteristically presented unilateral low tone nerve deafness with diplacusis. This unusual combination was similar to that observed in the 11 patients whose condition cleared up after removal of a focus of infection or a food allergy, so that had these 16 patients remained under observation the cause might have been determined for some of them. The following case is an example:

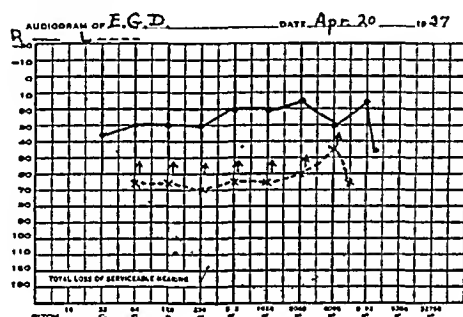


Fig. 8 (case 13).—Ménière's disease with inner ear deafness involving the low tones as well as the high tones and with diplacusis, all forks being heard at a higher pitch in the affected (left) ear.

CASE 13.—Mr. E. G. D., aged 60, complained of progressive loss of hearing in the left ear for three years, with tinnitus and attacks of vertigo and ataxia for two years. Two years previously he had consulted Dr. Furstenberg, who diagnosed the condition as Ménière's disease and prescribed a salt-free diet with ammonium chloride. On this regime the dizzy attacks were less severe and less frequent but had not been completely relieved. The hearing, however, had continued to grow worse. Hearing tests revealed unilateral nerve deafness, with greater loss for the low than for the high tones and with diplacusis, all forks being heard at a higher pitch in the affected ear. Further study was advised, but the patient did not return (fig. 8).

### PRIMARY NERVE DEAFNESS AND DIPLACUSIS WITH SPONTANEOUS RECOVERY (Two Cases)

CASE 14.—Mr. W. B. S., aged 56, complained of vertigo for six days. He was not aware of a defect in hearing, but tests showed definite lowtone nerve deafness in the left ear, with diplacusis. Three weeks later all symptoms had

cleared up. The patient during this time was under treatment for an infection of the bladder, which may have been the etiologic factor (fig. 9).

CASE 15.—Mrs. E. A. D., aged 59, a musician, complained of roaring, deafness and diplacusis in the right ear for two months. For ten months she had had a continuous cold in the head. Hearing tests revealed nerve deafness in the right ear, with loss for the low as well as the high tones and with diplacusis, all forks being heard at a higher pitch in the affected ear. Pus was obtained from the ethmoid sinuses by displacement suction. Three months later all the symptoms

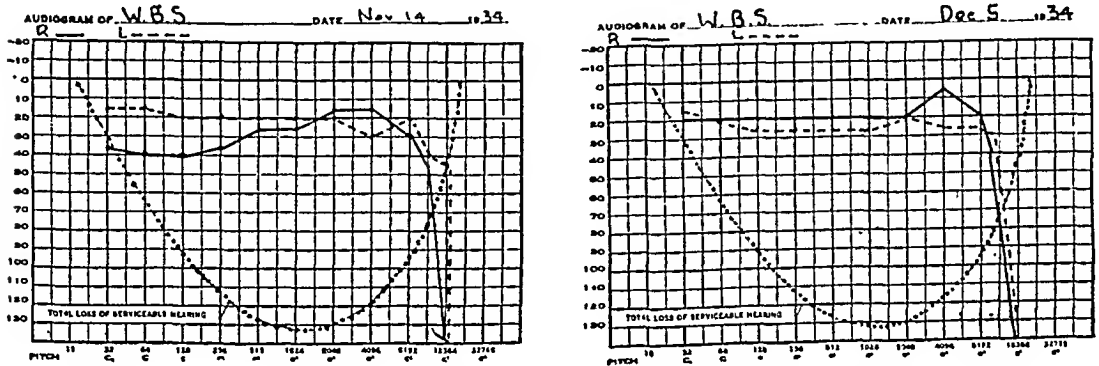


Fig. 9 (case 14).—Nerve deafness for low tones. On November 14 tests of the right ear showed that the 32 frequency fork was scarcely heard, that perception of the 64 frequency fork was slightly shortened and of the 2048 frequency fork normal and that the Rinne test was positive and perception as measured in the Schwabach test shortened. Diplacusis was present, the 32 and 64 frequency forks being heard at a higher pitch in the right ear. On December 5 tests of the right ear showed perception of the 32 and 64 frequency forks normal, and diplacusis was not present.

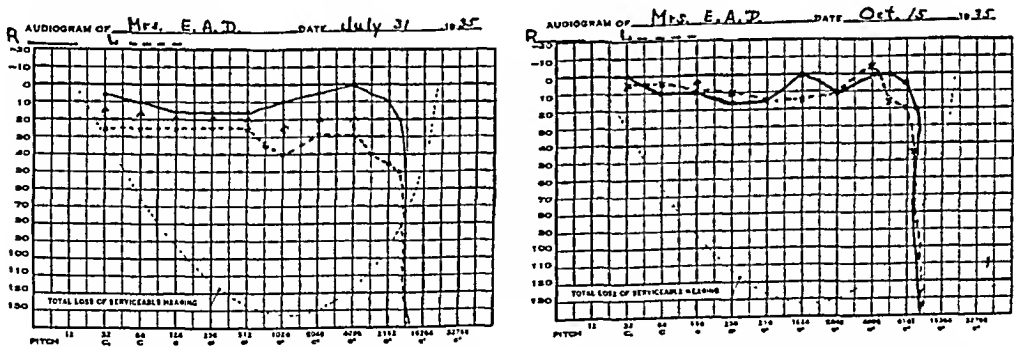


Fig. 10 (case 15).—Inner ear deafness with tinnitus and diplacusis, all forks being heard at a higher pitch in the left (affected) ear; return of hearing to normal and disappearance of diplacusis except for the 128 frequency fork; recurrence of all symptoms a week later.

had cleared up except that the 128 vibration fork was heard less than one-fourth tone lower in pitch in the affected ear. A week later the symptoms had all returned, with recurrence of diplacusis for all the forks. The patient was followed for a year, during which the hearing and diplacusis continued to fluctuate and the ethmoid sinuses continued to show evidence of infection. She was last seen two and a half years before the time of this report (fig. 10).

In retrospect the history suggests possible nasal allergy and allergy of the labyrinth. At the time, however, I was not aware of the possibility of allergy in such a disorder, and no attempt was made to discover an allergic factor.

### PRIMARY NERVE DEAFNESS AND DIPLACUSIS WITH APOPLECTIFORM ONSET (Two Cases)

CASE 16.—Mr. J. M., aged 19, complained of deafness in one ear for two years after concussion sustained in an accident during a game of football. The defect in hearing had not increased but had remained stationary. Hearing tests revealed nerve deafness with diplacusis, all the forks up to 1024 vibrations being

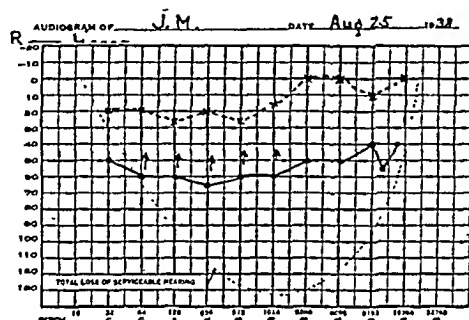


Fig. 11 (case 16).—Unilateral inner ear deafness following a blow on the head with diplacusis for the 64 to 1024 frequency forks, which were heard at a higher pitch in the affected ear (probable hemorrhage into the labyrinth).

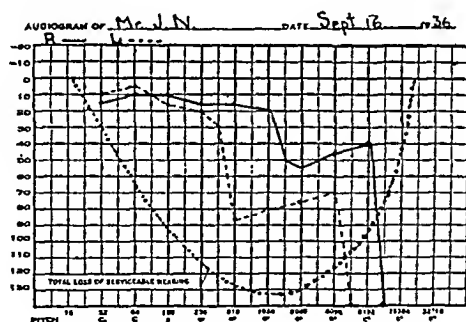


Fig. 12 (case 17).—Probable hemorrhage in the basal coil of the left cochlea. Tests of the left ear showed perception of the 32 frequency fork slightly shortened, that of the 64 frequency fork normal and the 2048 frequency fork scarcely heard. Diplacusis was present, the 64, 108, 128 and 2048 frequency forks all being heard at a slightly higher pitch in the left ear.

heard at a higher pitch and with a rough blowing quality in the affected ear. The sudden onset with concussion and the fact that the defect was stationary suggest a hemorrhage into the labyrinth with permanent distortion of the organ of Corti (fig. 11).

CASE 17.—Mr. J. N., aged 70, awoke one morning deaf in the left ear with ringing, nausea, vomiting and ataxia. Previous to this his left ear had been his

better-hearing ear. During the next two months the hearing improved somewhat and then reached a level at which it has remained stationary to the time of writing. Hearing tests reveal a sharply localized defect in the left ear, with diplacusis for the low-pitched forks, which are heard at a higher pitch in that ear. The age, the sudden onset, the single attack and the subsequent partial recovery suggest a hemorrhage into the basal turn of the cochlea, destroying most of the hearing for the high tones and distorting the vibrating membrane in the apical turns so as to produce diplacusis (fig. 12).

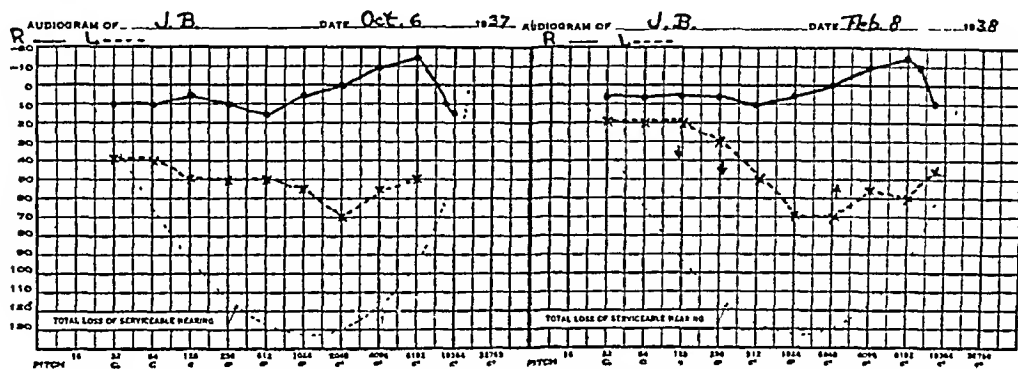


Fig. 13 (case 18).—Unilateral inner ear deafness from acoustic trauma with partial recovery of hearing and diplacusis for the 128 and 256 frequency forks, which were heard at a lower pitch in the affected ear.

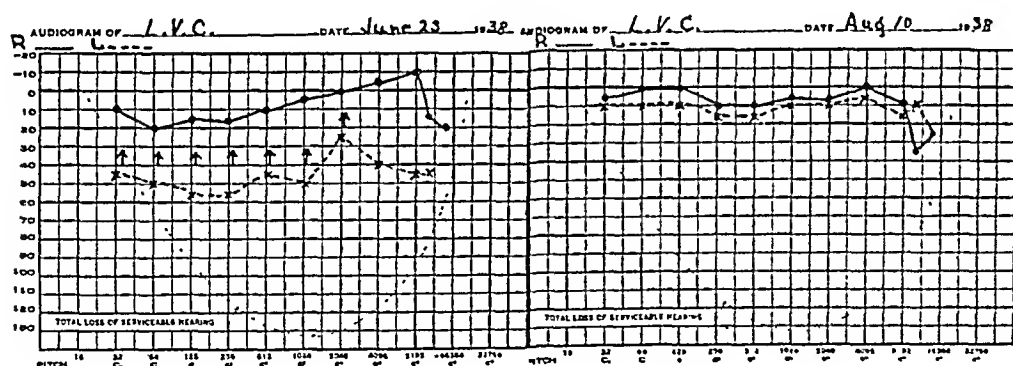


Fig. 14 (case 20).—Inner ear deafness involving low as well as high tones, with diplacusis, all forks being heard at a higher pitch in the affected ear: prompt return of normal hearing and disappearance of diplacusis, one week after the removal of a focus of infection.

#### PRIMARY NERVE DEAFNESS AND DIPLACUSIS FOLLOWING ACOUSTIC TRAUMA (TWO CASES)

CASE 18.—Mr. J. B., aged 33, complained of deafness and roaring in the left ear for ten days, which began while he was working with a new and extremely noisy machine. Hearing tests showed profound nerve deafness in that ear. Three months later the hearing for low tones had improved, but these were now heard at a lower pitch in the affected ear. The onset, the partial recovery and the diplacusis, all indicate a mechanically produced lesion of the vibrating elements in the cochlea (fig. 13).

CASE 19.—Mr. W. A. T. complained of a slight defect in hearing after a sudden loud static sound from a telephone receiver. Hearing tests gave normal results except for a slight impairment for the fork of 32 vibrations, with diplacusis, this fork being heard as a rattle rather than as a tone in the affected ear. The onset and the diplacusis suggest a mechanically produced lesion of the vibrating membrane in the apical turn of the cochlea.

#### NERVE DEAFNESS AND DIPLACUSIS WITH IMPROVEMENT OR RECOVERY AFTER REMOVAL OF A FOCUS OF INFECTION (SIX CASES)

CASE 20.—Mr. L. V. C., aged 33, complained of deafness and tinnitus in the left ear of three weeks' duration. Hearing tests revealed low tone nerve deafness with diplacusis, all forks being heard at a higher pitch in the affected ear. Removal of infected tonsils resulted in the disappearance of the tinnitus within four days and the return of normal hearing within a week. Previous to the tonsillectomy the deafness and tinnitus had shown no tendency to improve (fig. 14).

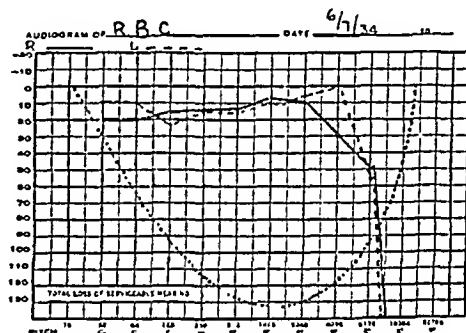
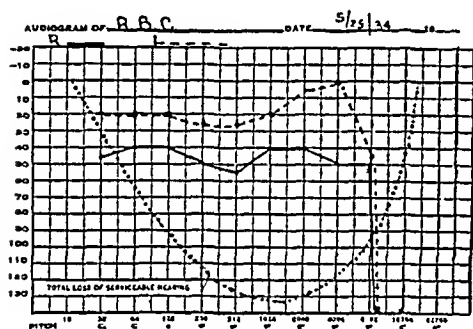


Fig. 15 (case 21).—Ménière's disease with unilateral inner ear deafness involving the low as well as the high tones, with vertigo, and diplacusis, all forks being heard at a higher pitch in the affected ear; prompt return of normal hearing one week after the removal of a focus of infection. Before tonsillectomy nerve deafness for low tones was present in the right ear. A whisper was heard at close range in the right ear and at 2 meters in the left; the 32 frequency fork was scarcely heard in the right ear, with normal perception in the left; perception of the 64 and 2048 frequency forks was slightly shortened in the right ear and normal in the left; the Rinne test was positive in both ears, and the reaction to the Weber test was lateralized to the left. Diplacusis was present, the 64, 108, 128 and 216 frequency forks being heard at a higher pitch in the right ear. One week after tonsillectomy a whisper was heard at 3.5 meters in the right ear and at 4 meters in the left; perception of the 32, 64 and 2048 frequency forks was normal in both ears; the Rinne test was positive in both ears, and the reaction to the Weber test was lateralized to the left. Diplacusis was still present, but six months later it had disappeared.

CASE 21.—Mr. R. B. C., aged 56, complained of tinnitus and deafness in the right ear, with attacks of vertigo, nausea, vomiting and ataxia for three months. Hearing tests revealed low tone nerve deafness with diplacusis, all forks being heard at a higher pitch in the affected ear. Removal of infected tonsils resulted in the complete disappearance of the tinnitus and the return of the hearing to normal within one week (fig. 15).

CASE 22.—Mr. W. R. W., aged 42, complained of attacks of vertigo for five years and of tinnitus and deafness in the left ear for two weeks. An orchestra sounded distinctly out of tune. Hearing tests revealed low tone nerve deafness with diplacusis, all forks being heard at a higher pitch in the affected ear. Removal of infected tonsils resulted in normal hearing six weeks later, and there have been no more attacks of vertigo at the time of writing (fig. 16).

CASE 23.—Mr. C. F., aged 42, complained of roaring and deafness in the left ear for one year. Hearing tests revealed a bilateral nerve defect, more marked in the left ear, with diplacusis, the forks being heard as a distinctly different sound in the two ears, though the patient was unmusical and could not distinguish pitch. Removal of infected tonsils resulted in an improvement in hearing almost to normal four weeks later, with the disappearance of the roaring which had been present for a year. A year later the diplacusis and impairment of hearing recurred during a sinusal infection. The patient was then lost track of (fig. 17).

CASE 24.—Miss U., aged 40, complained of high-pitched tinnitus in the left ear for seven weeks. The hearing was normal, and the cause of the tinnitus was

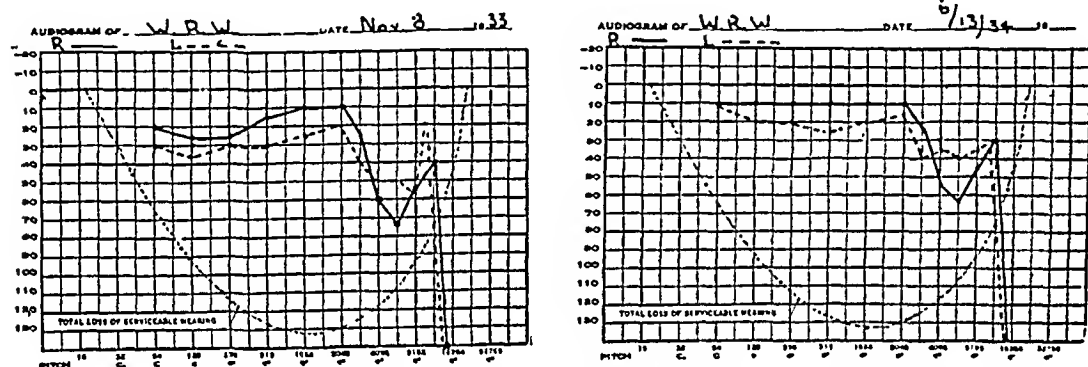


Fig. 16 (case 22).—Ménière's disease with inner ear deafness involving low as well as high tones and diplacusis, all forks being heard at a higher pitch in the affected ear; complete recovery six weeks after the removal of a focus of infection. Nerve deafness for low tones was present on the left; the 32 frequency fork was not heard, and perception of the 64 frequency fork was moderately, and that of the 2048 frequency fork slightly, shortened. The reaction to the Weber test was lateralized to the right; the Rinne test was positive in the left ear, and the reaction to the Schwabach test was normal. Diplacusis was present for all tones, the sounds appearing of poor quality and lower in pitch in the left ear. Six weeks after tonsillectomy perception of the 32 and 64 frequency forks was normal and that of the 2048 frequency fork slightly shortened on the left. Diplacusis was not present.

not found. Three months later she returned because of an increase in the tinnitus, with a distinct jarring discomfort in the affected ear when it was exposed to loud sounds. Hearing tests now disclosed low tone nerve deafness in that ear, with diplacusis for the low-pitched forks. Removal of two dead teeth, one of which proved to be abscessed in spite of a normal roentgenogram, resulted in marked improvement in the tinnitus within a week and complete recovery soon afterward. Three months later the symptoms returned, with three attacks of vertigo, but they cleared up spontaneously within a few weeks and have not recurred at the time of writing (fig. 18).



CASE 25.—Mrs. M. A. W., aged 70, complained of nasal symptoms, which proved to be due to chronic maxillary sinusitis. For six or seven years she had had defective hearing and roaring in the right ear. Three years before I saw her she had had a series of attacks of severe vertigo, nausea, vomiting and ataxia. She had visited a university clinic, where an audiogram was obtained; the tuning fork tests showed unilateral nerve deafness, and she was placed on a salt-free diet, with relief from the attacks of dizziness. Hearing tests when I saw her showed low tone nerve deafness with diplacusis, the low forks being heard at a higher pitch in the affected ear. The interesting thing is that clearing up the chronic maxillary sinusitis by a series of irrigations resulted in the restoration of hearing nearly to normal (fig. 19).

Five of the 6 cases of low tone nerve deafness and diplacusis with recovery after removal of a focus of infection have been reported previously. As was pointed out at that time, the age of the patients, the response to removal of a focus of infection and the frequent tendency to recurrences, all suggest a similarity to iritis. It was suggested that

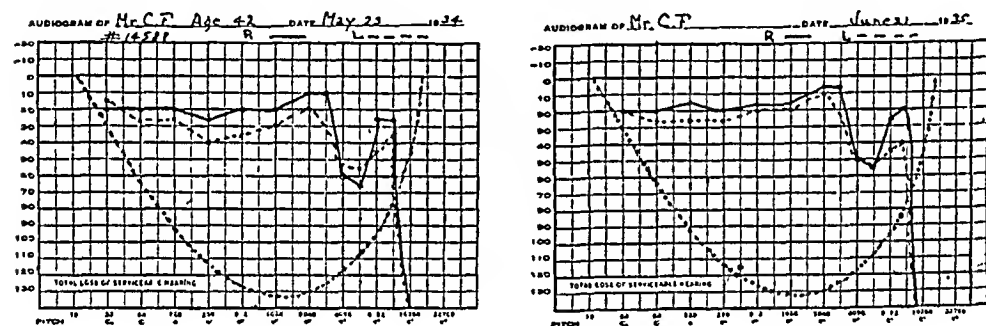


Fig. 17 (case 23).—Inner ear deafness involving low as well as high tones and diplacusis, all forks being heard at a higher pitch in the affected ear; return of normal hearing four weeks after the removal of a focus of infection. Before tonsillectomy nerve deafness for low tones was present in the left ear, with perception of the 32 frequency fork much shortened and that of the 64 and 2048 frequency forks slightly shortened; the Rinne test was positive in the left ear, and perception as measured in the Schwabach test was shortened. Diplacusis was present for the 64, 108 and 128 frequency forks, but the patient was not musical and could not say whether the sound was higher or lower in the affected ear. Four weeks after tonsillectomy perception of the 32, 64 and 2048 frequency forks was normal in the left ear. Diplacusis was present for the 64, 108 and 128 frequency forks.

the pathologic change in these cases is an inflammatory process in the labyrinth caused by focal infection elsewhere in the body. This inflammatory change results in edema or thickening of the vibrating membrane, thus causing the diplacusis.

#### PRIMARY NERVE DEAFNESS AND DIPLACUSIS WITH IMPROVEMENT OR RECOVERY AFTER REMOVAL OF AN ALLERGIC FACTOR (FIVE CASES)

CASE 26.—Mr. D. A. complained of tinnitus and increasing deafness in the left ear for many years, with attacks of vertigo, nausea, vomiting and ataxia

for four years, gradually increasing in frequency. A salt-free diet with ammonium chloride had failed to relieve the dizziness. Hearing tests disclosed low tone nerve deafness with diplacusis, all forks being heard at a higher pitch and with a buzzing quality in the affected ear. The nasal smear revealed a definite increase in eosinophils. An elimination diet excluding the common causes for food allergy, such as wheat, milk, eggs, and chocolate, resulted in complete relief from the dizziness. The addition of wheat was followed by a recurrence of the vertigo.

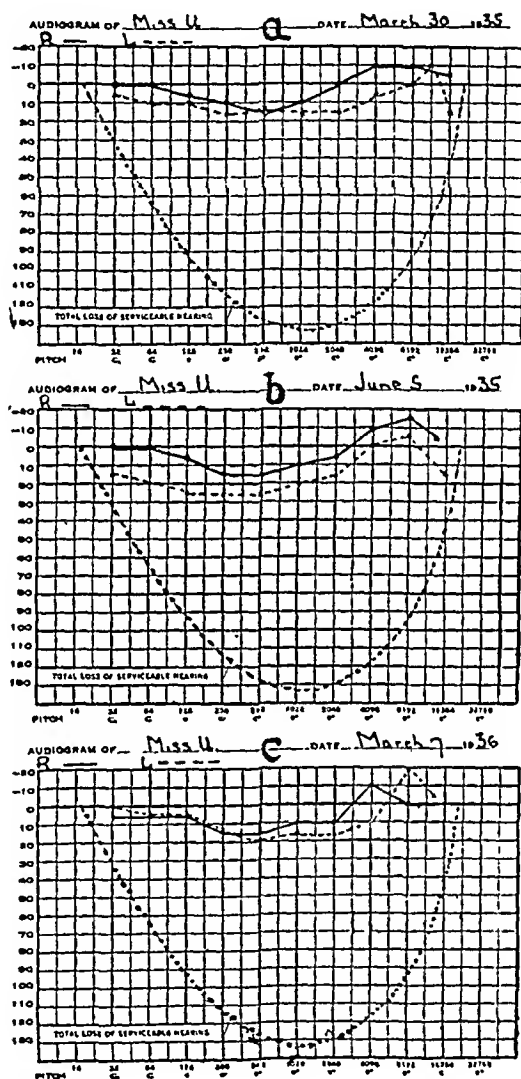


Fig. 18 (case 24).—Inner ear deafness involving low more than high tones and diplacusis for the low tones, which were heard at a higher pitch in the affected ear; recovery of normal hearing one week after the removal of a focus of infection. At the first examination the hearing was normal, with perception of the 32 frequency fork very slightly shortened in the right and slightly shortened in the left ear and that of the 64 and 2048 frequency forks normal in both ears (a). Later, nerve deafness for low tones and diplacusis were present in the left ear; perception of the 32 frequency fork was very slightly shortened in the right ear, and the fork was scarcely heard in the left; perception of the 64 frequency fork was normal in the right ear and moderately shortened in the left, and that of the 2048 frequency fork was normal in both ears (b). After operation, normal hearing returned, and the diplacusis largely disappeared: perception of the 32, 64 and 2048 frequency forks was normal in both ears (c).

The addition of other foods and the exclusion of wheat has resulted in permanent relief from the dizziness. The hearing has improved slightly, but the diplacusis persists (fig. 20).

CASE 27.—Col. G. V., aged 47, complained of tinnitus in the right ear for six weeks and an attack of dizziness and nausea eight days previously. Hearing tests revealed slight low tone nerve deafness in the affected ear, with diplacusis, the low-pitched forks being heard at a higher pitch and with a peculiar vibrating quality in that ear. The nasal smear showed an increased proportion of eosinophils,

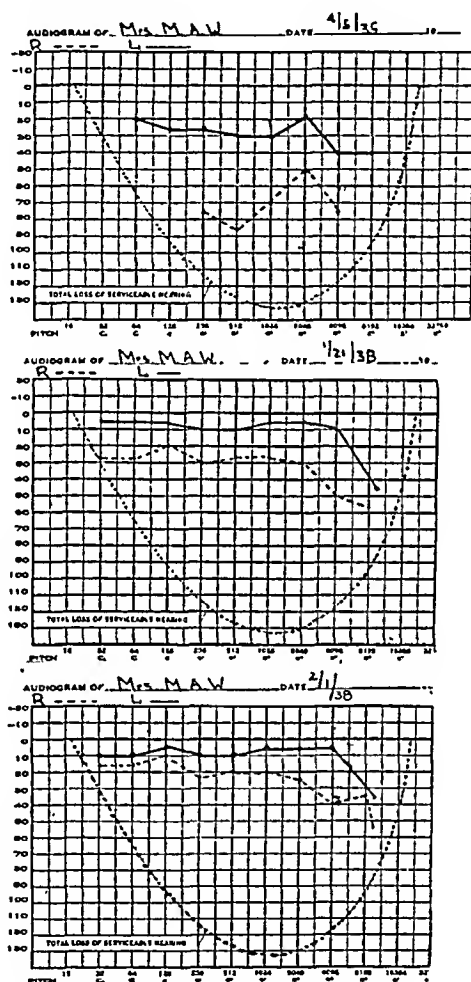


Fig. 19 (case 25).—Ménière's disease with a profound defect in hearing and diplacusis, the low-pitched forks being heard at a higher pitch in the affected ear; marked improvement in hearing, nearly to normal, after removal of a focus of infection.

and there were symptoms of chronic rhinitis. Because wheat is the most frequent cause for food allergy in the upper respiratory tract it was removed from the diet. The chronic rhinitis, which had lasted four months, and the tinnitus and diplacusis, present for six weeks, cleared up completely within two weeks.

CASE 28.—Miss E. L., aged 58, complained of tinnitus and gradual impairment in hearing in the left ear, with attacks of vertigo, nausea, vomiting and

ataxia for one year. Hearing tests revealed low tone nerve deafness in the left ear, with diplacusis, all forks being heard at a higher pitch in that ear. A diet with a low salt content with ammonium chloride failed to relieve the dizziness. An elimination diet omitting wheat, eggs, chocolate, nuts, onions, garlic and condiments resulted in complete relief. The addition of eggs was followed by a recurrence. At the time of writing the patient is omitting eggs and the other foods enumerated and prefers to follow this diet rather than to experiment with adding foods and running the risk of more spells of dizziness.

CASE 29.—Mrs. F. T. M., aged 23, complained of tinnitus and deafness in the left ear, vertigo, nausea, vomiting and ataxia, all for three days. For two years she has experienced periods of impaired hearing in the left ear, not related to colds in the head. Hearing tests revealed low tone nerve deafness in the left ear, with diplacusis confined to the 2048 vibration fork, which was heard three or four tones higher in pitch in that ear. There was spontaneous nystagmus toward the affected ear. Because she suspected that coffee and orange juice disagreed with her and because the attack of dizziness followed the ingestion of an unusual amount of coffee, the patient was advised to omit coffee and orange

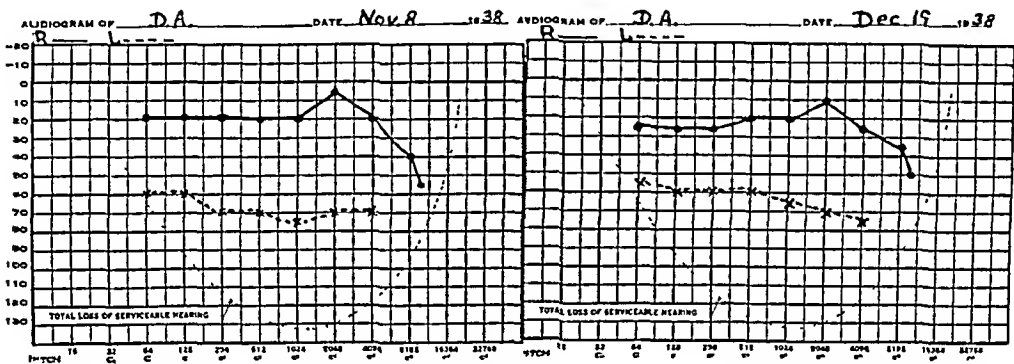


Fig. 20 (case 26).—Ménière's disease with inner ear deafness involving low as well as high tones and diplacusis, all forks being heard at a higher pitch in the affected ear. No improvement on Furstenberg's regimen; complete freedom from vertigo on removing wheat from the diet, with recurrence on adding wheat; slight improvement in hearing.

juice from her diet. The symptoms improved greatly but recurred when she took a cup of coffee a week later. At the time of writing she has been relatively free from aural symptoms for five months.

CASE 30.—Mrs. P. W. P., aged 50, complained of roaring and deafness in the left ear for a year. Removal of an infected remnant of a tonsil and of several infected teeth resulted in marked improvement in the hearing, but soon the symptoms returned. She complained that her husband's voice sounded harsh and disagreeable in the affected ear, and hearing tests revealed low tone nerve deafness with diplacusis, the low-pitched forks being heard at a higher pitch in that ear. The hearing fluctuated widely for the next two months. She then experienced a sudden attack of vertigo, nausea, vomiting and ataxia. Removal of infected lateral pharyngeal bands was followed by improvement in the hearing and the roaring. For a year she remained free from aural symptoms, and then the tinnitus, low tone nerve deafness and diplacusis, all recurred. No focus of infection could be found, and the deafness and tinnitus persisted for six months. Finally an elimination diet was advised, the foods commonly causing allergy being excluded.

Within a few days the hearing, which had been poor for six months, improved markedly. The addition of milk was followed within a few hours by a red, sore rash in the mouth, with puffiness of the lower lip. The patient then mentioned that ingestion of milk and cream had often resulted in a sore mouth. Milk, cream, butter and cheese were therefore excluded and all other foods added to her diet, and on this regime the hearing returned to and remained normal. To prove definitely that allergy to milk was the cause of the aural trouble it was suggested to the patient that she add milk to her diet for a week. This was done and resulted in profound deafness, much worse than she had ever had before, with a discharge of thin serum from the middle ear, which began painlessly and lasted ten days. Milk, cream, butter and cheese were immediately removed permanently from her diet. The otitis media cleared up, and the hearing slowly returned to normal, at which it has remained (fig. 21).

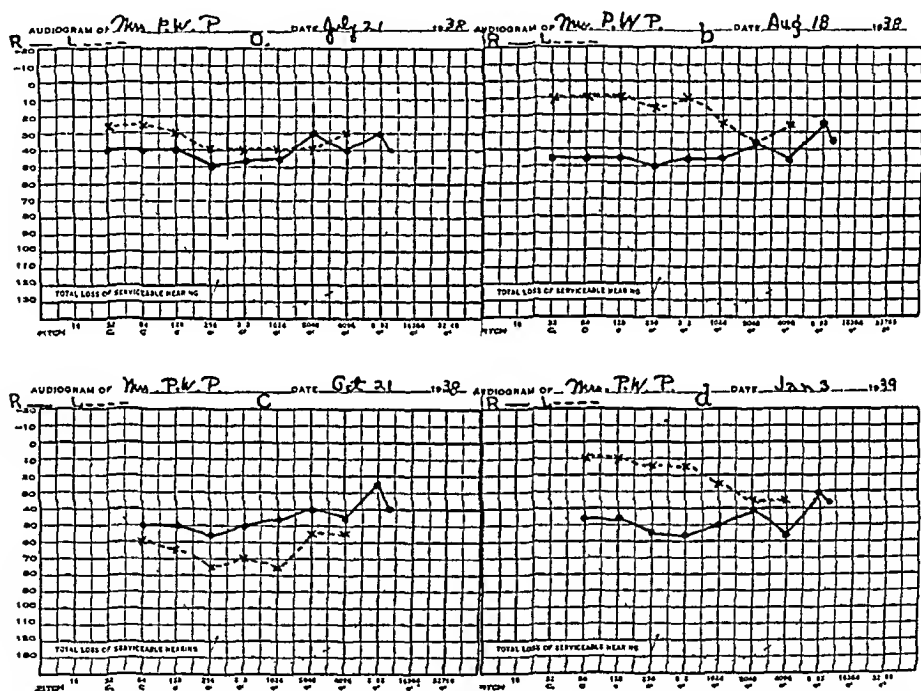


Fig. 21 (case 30).—Inner ear deafness (left) involving low as well as high tones and diplacusis, all forks being heard at a higher pitch in the left ear, with a conduction defect (right) due to a total perforation of the drum membrane (a); return of hearing to normal on removing milk from the diet (b); profound inner ear deafness within a few days of adding milk to the diet (c); return of normal hearing after excluding milk from the diet again.

### COMMENT

Analysis of the 45 patients with diplacusis shows that in every case, except that of the patient with normal hearing, there is evidence of a lesion in the inner ear. In the few cases of otitis media with diplacusis there was always associated acute serous labyrinthitis. Clinical experience, therefore, confirms the theoretic statement that diplacusis can be caused only by a lesion of the organ of Corti.

Attacks of vertigo occurred in many of the patients with inner ear deafness and diplacusis so that the cases may be regarded as instances of Ménière's disease (cases 13, 14, 21, 22, 24, 25, 27, 28, 29 and 30). Since including the test for diplacusis in the routine hearing tests I have found the symptom in the great majority of patients with Ménière's syndrome. This means that the lesion of Ménière's disease is in the membranous labyrinth. In some cases it is apparently the result of focal infection (cases 21, 22, 24 and 25). As Crowe<sup>5</sup> pointed out, one must be guarded in assessing the value of any therapeutic measure for Ménière's disease, because of the spontaneous remissions that occur so often. However, in case 21, in which the tinnitus and deafness had persisted for three months only to clear up completely within a week after tonsillectomy, it is difficult not to conclude a causal relation. In case 22 mild dizzy spells of five years' duration completely ceased after tonsillectomy, a result that seems more than a coincidence. Wright<sup>6</sup> has pointed out also that Ménière's disease may be caused by focal infection, and he noted the similarity between the clinical course of iritis and of Ménière's disease, a similarity which I pointed out several years earlier.<sup>7</sup>

It seems unlikely that in all cases Ménière's disease is due to focal infection. Allergy causes it in at least some cases (cases 26, 27, 28, 29 and 30). Here again one must be guarded in interpreting the results of therapy. Conclusive proof of an allergic cause is obtained by relief from symptoms when the substance is avoided and a recurrence of symptoms on exposure to the substance followed again by relief on its removal. Such proof was obtained in cases 26 and 30.

The idea that allergy may be responsible for Ménière's disease in some cases is not new. Duke, Kobrak, Proetz, Yandell, Vaughn and Hawke, Vogel, Urbach and Wilder, Malone, Rowe and Richet, were all cited by Dean, Agar and Linton<sup>8</sup> as reporting cases of Ménière's disease due to allergy. The latter authors report a series of additional cases. Jones<sup>9</sup> described an instance of Ménière's disease due to allergy to milk. Campbell<sup>10</sup> and Dohlman<sup>11</sup> observed cases of Ménière's diseases due to allergy to specific foods.

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11. Dohlman, G.: Personal communication to the author.

The first histologic study of the ear in the presence of Ménière's disease was made recently by Hallpike and Cairns.<sup>12</sup> They observed extreme and uniform dilatation of the endolymphatic system. They expressed themselves as unable to explain this increase of endolymph but suggested that sudden changes in pressure of the endolymph cause anoxemia of the labyrinth. They suggested that stretching of the basilar membrane might lead to a change in its vibration and diplacusis. Since these observations were made on patients who died in the interim between attacks, it is conceivable that the picture observed by the authors is the residuum after acute attacks of allergic edema of the membranous labyrinth. The peculiar fluctuating nature of the deafness in Ménière's disease pointed out by Crowe<sup>5</sup> is consistent with an allergic disorder or with an inflammatory lesion resulting from a focus of infection. The beneficial results obtained by Furstenberg and his co-workers<sup>13</sup> by a restricted sodium-low diet and rest in bed for Ménière's disease are not entirely inconsistent with an allergic disorder, while the finding of subcutaneous edema in patients with Ménière's disease by Mygind and Dederding<sup>14</sup> is suggestive of allergy.

A word should be said concerning the inner ear deafness for low tones which I have observed in patients with Ménière's disease and diplacusis. The loss of hearing for low tones may be as great as or greater than that for high tones. This has led Mygind and Dederding to the statement that, although the patients have shortened perception by bone conduction, they have middle ear deafness and that, therefore, shortened perception as measured in the Schwabach test does not indicate inner ear deafness! My reasons for believing that the defect in perception of low tones in such cases is due purely to a lesion in the inner ear are as follows:

1. Perception as measured in the Schwabach test is always shortened.
2. When reaction to the Weber test is lateralized, the sound is always heard in the better hearing ear.
3. The Rinne test remains positive even with a considerable defect in the affected ear.
4. The drum membrane and eustachian tube are normal, and inflation does not result in demonstrable improvement in hearing.

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12. Hallpike, G. S., and Cairns, H.: Observations on the Pathology of Ménière's Syndrome, *J. Laryng. & Otol.* **53**:625 (Oct.) 1938.

13. Furstenberg, A. C.; Lashmet, F. H., and Lathrop, F.: Ménière's Symptom Complex: Medical Treatment, *Ann. Otol., Rhin. & Laryng.* **43**:1035 (Dec.) 1934.

14. Mygind, S. H., and Dederding, D.: Ménière's Disease as an Indication of Disturbances in the Water Metabolism, Capillary Function, and Body Condition. *Ann. Otol., Rhin. & Laryng.* **47**:55 (March) 1938.

5. Marked fluctuations in hearing are not accompanied by visible or demonstrable changes in the middle ear or eustachian tube.

Crowe<sup>5</sup> did not mention the loss of hearing for low tones, but his audiograms clearly show it. He and Wright agreed in stating that the defect in hearing in Ménière's disease is a type of inner ear deafness.

Disease of the membranous labyrinth may be confined to the vestibular portion; it may involve both the vestibular apparatus and the cochlea, or it may affect the cochlea alone. In the first instance there will be vertigo without deafness; in the second, vertigo with deafness, and in the third, deafness without vertigo. The disease, however, remains essentially the same, namely, a chronic or recurrent involvement of the membranous labyrinth. This disease is characterized by the following peculiarities which constitute a symptom complex or syndrome:

1. Attacks of vertigo.

2. Inner ear deafness with loss of hearing for the low tones as often as for the high tones and with a tendency to marked fluctuations.

3. Diplacusis with a tendency to fluctuate.

4. Tinnitus which tends to fluctuate.

The etiology of this chronic disease of the membranous labyrinth is not yet entirely clear. Focal infection seems to be a factor in some cases. Allergy is definitely the cause in some cases. The term "Ménière's disease" is not satisfactory for this chronic disease of the labyrinth, since it refers only to attacks with vertigo. Some term should be used to include the attacks without vertigo but with the other symptoms of the syndrome. "Chronic nonsuppurative labyrinthitis" might be a suitable term except when a specific allergy is proved, in which event "allergic labyrinthitis" is the proper term.

### CONCLUSIONS

1. Diplacusis is due to a lesion of the organ of Corti.

2. Diplacusis is a more frequent symptom than is generally appreciated, but to be detected it must be specifically tested for.

3. The test for diplacusis is simple, quick and reliable. It is best done with tuning forks.

4. Diplacusis occurs in the following clinical conditions:

- (a) Otosclerosis with labyrinthine involvement (cases 3 and 4).

- (b) Acute serous labyrinthitis secondary to acute or chronic suppurative otitis media (cases 8, 9, 10, 11 and 12).

- (c) Operative trauma to the membranous labyrinth (cases 5, 6 and 7).

- (d) Hemorrhage into the labyrinth (probably cases 16 and 17).



- (e) Acoustic trauma to the labyrinth (cases 18 and 19).
- (f) Labyrinthitis resulting from focal infection (cases 20, 21, 22, 23, 24 and 25).
- (g) Labyrinthitis due to allergy (cases 26, 27, 28, 29 and 30).

5. Diplacusis is found in most cases of Ménière's disease with defective hearing.

6. Ménière's disease is due to nonsuppurative labyrinthitis, sometimes allergic, sometimes the result of focal infection. There may be vertigo without deafness, vertigo and deafness or deafness without vertigo, according to whether the entire membranous labyrinth or only a portion is involved.

7. Perception deafness due to a lesion of the membranous labyrinth is characterized by the following conditions:

- (a) The hearing for low tones is impaired as frequently as that for high tones.
- (b) Diplacusis is present.
- (c) Vertigo is frequent.
- (d) In many cases, the pathologic lesion is reversible, at least in the early stages, so that the hearing is subject to marked fluctuations, and it may return to normal if the etiologic factor is removed.

#### ABSTRACT OF DISCUSSION

DR. ARTHUR W. PROETZ, St. Louis: Dr. Shambaugh has observed the cases over a long period. Diplacusis has been understood and described for several generations, but it has never occurred to anybody to deduce from observations that the fault lay in the cochlea and not somewhere along the line, as might have been deduced provided that the Helmholtz resonator theory is accepted.

Knowingly or not, Dr. Shambaugh has contributed a bit of evidence in favor of the resonator theory. In each case in his list, with one exception, the pitch was raised, no matter for what part of the scale the perception was affected.

The physical laws of vibrating bodies are well known. The fundamental resonance depends on length and mass and volume, and if the lesion can be conceived as a swelling of the organ of Corti naturally all these factors are increased and the tone would be expected to rise in pitch.

It seems to me that if there were some infection of the central apparatus the deviation might occur in any direction. It is hard to think that a lesion would extend only in such a direction, centrally, as to produce a perception of higher pitch and never a lower pitch. With a lesion in the cochlea, this is easily understood.

As Dr. Shambaugh says, diplacusis is not rare. I experienced it a few years ago myself and so became interested in it. After an acute attack of otitis media, so acute that the drum ruptured before I could get any help, the diplacusis appeared, beginning at 1024 vibrations and getting worse as the pitch rose, to 16000 vibrations, at which there was a difference of four and a half tones between the true

pitch and that heard in the infected ear; that is, F sharp was heard instead of C. Fortunately, two audiometers, one with a continuous range of pitch, were at hand, so that the phenomenon could be studied. It lasted twelve days. But nowadays I do not use a tuning fork for testing diplacusis, and I find the best means at my disposal is a two way double ear phone, now to be had from at least one audiometer manufacturer, which was originally intended as a test for malingering. The switch is so arranged that the tone can be given first to one ear, then gradually to both and finally to the other, without variation in pitch or in intensity. If this double earphone is given a patient and a certain tone is sent at a certain volume through the audiometer, the patient will report hearing either one tone or two tones, and it is especially valuable for persons who have no musical sense. There is a particular facility that one can develop in eliciting the symptom from such persons. A musician will say at once, "I hear a triad," or "I hear a dissonance," or "I hear a consonance" or something else besides the one tone that the examiner is making. The person who is not musical simply says, "It is a rasping noise."

It is, after all, a dissonance produced by a slight rise in the pitch perceived in one ear.

Dr. Shambaugh has been modest in confining his conclusion to the localization of the lesion in the cochlea. With further study he may be able to localize it still further, because obviously in some cases the high pitches are involved and in other cases the low pitches, which may give an even better understanding of the suggestion. As a matter of fact, it is in cases of inflammation, usually, that the high pitches are affected, as might be expected from the positions of the various turns of the cochlea.

DR. GEORGE N. COATES, Philadelphia: I am not in the fortunate position of Dr. Proetz, who can discuss this interesting paper from firsthand knowledge, having experienced the condition himself. Most otologists are compelled to depend on the patient's own statements that there is a disharmony in the tones perceived in the two ears in diplacusis binauralis dysharmonica, which is the common type and, in fact, the only type with which they are familiar.

I strongly suspect that the majority of otologists do not routinely search for this symptom, but only notice it when it is specifically called to their attention by an unusually observant patient. Such patients in my experience have been musicians or at least devotees of symphonic or other high class music, in other words, those who have musically trained ears.

From Dr. Shambaugh's interesting case reports, it is evident that otologists should be more careful in their investigations in this respect and that if they are they will have another valuable aid to diagnosis and prognosis. I further suspect that if they make a routine practice of this type of testing, they will be rewarded by finding the symptom in more cases than they formerly thought likely.

Without any real study of the subject, I have always assumed that diplacusis must be due to some pathologic condition in the labyrinth, temporary or permanent, which in some way changed the vibrating mechanism in the organ of Corti. This is indicated by the deductions that the author has drawn from a rather large series of cases, in all of which, irrespective of the causation, labyrinthine involvement and perceptive deafness for either high or low tones and in many of which vestibular symptoms, appeared. Even in the cases of otosclerosis the condition at least started with, or was complicated by, cochlear otosclerosis, and the cases in which the symptom was observed after fistulization are especially interesting.

As for the diagnosis, I believe that Dr. Shambaugh is quite right in saying that careful testing with the tuning forks over the whole series of octaves to at

least 2048 double vibrations is the best if not the only way to confirm the patient's statements, and this takes time and patience. The method outlined is admirable, particularly if the person being tested is able to reproduce the different pitch heard in each ear. When this is done, the examination is conclusive.

In respect to the probability of pathologic change in the cochlea as the cause of this condition, one must wait for pathologic diagnosis at autopsy before one can be sure. In the case of trauma, whether acoustic or with hemorrhagic distortion of structure by direct violence or by the formation of cicatrices seems a ready explanation. Such occurrences should be accompanied by permanent loss of hearing in most instances, and it seems that the diplacusis also might be permanent. When the condition is attributable to allergy or to focal infection, it may well be that serous labyrinthitis or edema, similar to that seen in other parts of the body in the same cases, causes the distortion in the membranous labyrinth that causes the disharmony. Clinical results certainly seem to corroborate this thesis, since on the removal of the source of infection or of the offending allergens not only does other edema subside but the impaired hearing, the vestibular symptoms and the diplacusis improve as well.

I wish that Dr. Shambaugh in his closing discussion would amplify the remarks contained in the last paragraph of his paper relative to the differential diagnosis and prognosis in cases of nerve deafness.

DR. GEORGE E. SHAMBAUGH JR., Chicago: The use of the special audiometer described by Dr. Proetz for detecting diplacusis is helpful. That type of audiometer, however, is certainly not available to most otologists. I use a 1-A audiometer with which the sound can be shifted from one ear to the other, but it is extremely difficult to get the intensity of the tone equal in both ears. With a tuning fork that is done easily. One holds the fork in front of the normal and then the affected ear, regulating it until the intensity is equal. Few persons can distinguish between pitch and intensity. One has to get the intensity exactly equal and then ask about the pitch.

Dr. Coates asked me to amplify the last paragraph, concerning the differential diagnosis of the two types of nerve deafness. In most cases nerve deafness, as illustrated by the senile type or the type which follows prolonged exposure to loud noises, consists essentially, pathologically, of degeneration of the cells of the spiral ganglion. That type of lesion is not reversible; once it has occurred, the deafness is permanent, and treatment has no effect. A lesion involving the vibrating membrane in the organ of Corti, however, particularly if it is an inflammatory or an allergic edema, is essentially reversible, and if the cause is determined and removed before permanent changes have occurred the hearing should return to normal.

122 South Michigan Avenue.

## Case Reports

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### ADENOCARCINOMA ARISING FROM THE MUCOUS GLANDS OF THE PALATE WITH PULMONARY METASTASES

J. G. SHARNOFF, M.D., AND J. R. LISA, M.D., NEW YORK

The purpose of this report is to present a case of true adenocarcinoma of the palate originating in the mucous glands with metastases to the regional lymph nodes and the lungs. The term "true" is used in order to differentiate this tumor from the several tumors which have been reported in the literature as adenocarcinoma by Ribbert,<sup>1</sup> Boenninghaus,<sup>2</sup> Coenen<sup>3</sup> and others. The latter neoplasms were designated by these authors as adenocarcinomas, although clinically and histologically they fall into the controversial group of relatively benign tumors more commonly referred to by others as cylindromas. These authors stated the belief that the tumors were really epithelial, as first suggested by Ribbert. The tumor that is described in this report differs clinically as well as histologically from those mentioned. Other reports in the literature refer only to squamous cell epitheliomas or mixed tumors of the palate. New and Childrey<sup>4</sup> in a report of 220 malignant growths of the palate seen at the Mayo Clinic from 1917 to 1930 failed to find 1 instance of adenocarcinoma.

#### REPORT OF A CASE

A Negress 39 years old was admitted to City Hospital, otolaryngologic service of Dr. O. C. Risch, on Feb. 2, 1939, with increasing difficulty in speech of nine months' duration, increasingly severe cough, pain in the chest and shortness of breath for several weeks. She stated that she had been treated at the Vanderbilt Clinic since June 1938. A report from that institution stated that the patient had noted a hard tender mass in the neck and soreness of the throat for about two months. It was noted that she had a nasal quality to the voice. She gave a history of having received injections in the arm and hip for more than a year. Examination revealed a destructive lesion of the roof of the mouth, which was difficult to see because of trismus. The soft and hard palates were destroyed in the midline as far forward as the second molar tooth. A lesion measuring 2 by 2.5 cm. contained a perforation 3 mm. in diameter in its center. The edge was red and

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From the Pathological Laboratory, City Hospital, Welfare Island, Department of Hospitals.

1. Ribbert, H.: *Geschwulstlehre für Aerzte und Studierende*, ed, 2, Bonn, F. Cohen, 1914, pp. 591-601.

2. Boenninghaus, G. K. M.: *Der Drüsenkrebs des harten Gaumens*, Beitr. z. klin. Chir. **111**:215, 1918.

3. Coenen, H.: *Ueber Gaumengeschwülste*, Arch. f. klin. Chir. **75**:542, 1904.

4. New, G. B., and Childrey, J. H.: *Tumors of the Tonsil and Pharynx: Three Hundred and Fifty-Seven Cases; Malignant Tumors Exclusive of Adenocarcinoma of the Mixed Tumor Type: Two Hundred and Twenty Cases*, Arch. Otolaryng. **14**:713 (Dec.) 1931.

somewhat granular. Considerable mucus was present in this area. The cervical nodes on the left were enlarged and hard, the largest in the region of the angle of the jaw. A Kline test gave a 3 plus reaction. A specimen taken for biopsy from the soft palate was reported as showing carcinoma with the comment, "Whether this is a metastatic carcinoma or a primary carcinoma arising from the mucous glands it is impossible to say from this section." Roentgen examination of the chest revealed evidence of metastases. The patient was given extensive radiotherapy to the soft palate and neck, as well as palliative therapy to the chest.

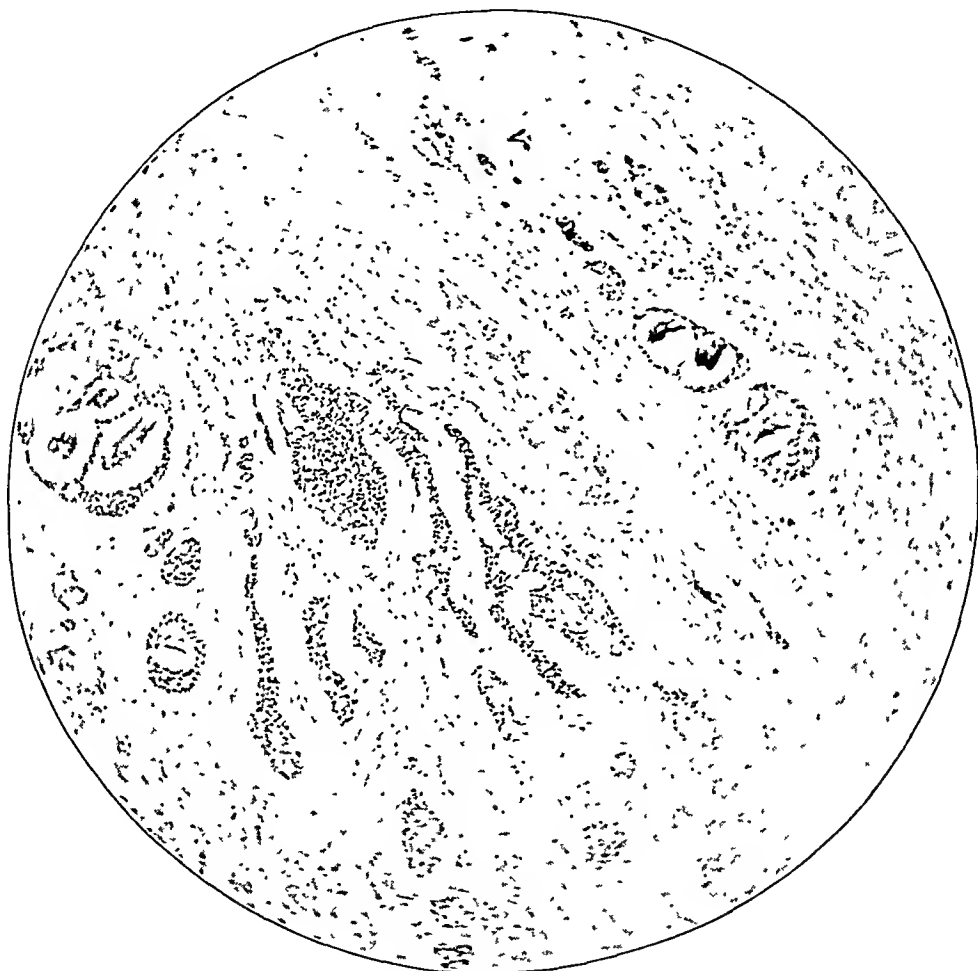


Fig. 1.—Section from the palate revealing the morphologic picture and the invasive character of the primary tumor.

Physical examination on the patient's admission to the City Hospital revealed an emaciated, chronically ill Negress with dyspnea and orthopnea. The essential physical findings were a clean, punched-out perforation in the midline of the palate and a few firm, somewhat enlarged, moderately fixed cervical lymph nodes. The examination of the chest revealed slight dulness to percussion and patches of fine crackling rales over the right anterior thoracic wall. A few scattered rales were heard at both bases posteriorly. The other physical findings were essentially negative except for the marked emaciation. A roentgenogram of the chest revealed

bizarre shadows in the lower half of the left pulmonary field suggestive of metastases. The Wassermann reaction of the blood was 4 plus. A clinical diagnosis of bronchopneumonia and carcinoma of the palate with metastases to the lymph nodes and the lungs was made. The patient died on February 6.

*Necropsy.*—Only the pertinent findings are abstracted. The body was that of a moderately well developed and markedly undernourished Negress. The mouth was opened with difficulty. A firm mass could be felt in the soft palate extending to

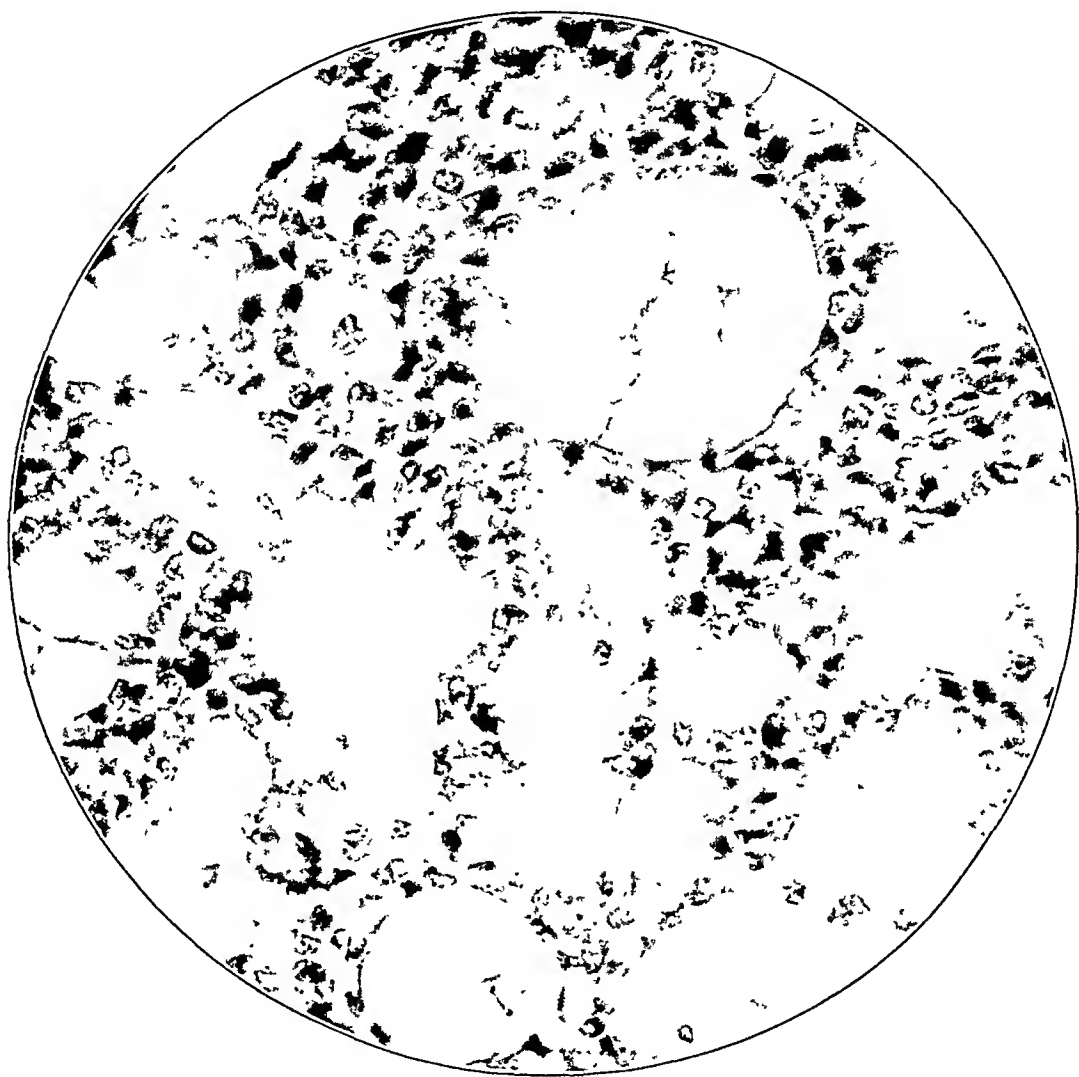


Fig. 2.—Section from the lung showing the morphologic picture of the metastases under higher magnification. The mucoid secretion is especially noticeable and prominent.

the left lateral wall of the pharynx. A small perforation with a regular smooth edge was noted to the left of the midline in the soft palate. The pleural cavities were free of fluid, the surfaces smooth, glistening, moist and free of adhesions. The lungs were moderately voluminous. Several round or irregularly oval firm elevated areas of lighter color than the surrounding slate gray lung were noted. On section these areas were circumscribed, nodular, and rubbery with a gray dry surface. They were gray-white with moderate anthracotic markings. These areas were scattered throughout all the lobes, chiefly at the periphery of the lower

lobe of the right lung. Several smaller nodules nearer the hilus were lying close to small blood vessels. In addition there were a few small recent infarctions with thrombosis of the arteries.

*Histologic Picture.*—Sections of the soft palate revealed a normal stratified squamous epithelium covering a dense irregular connective tissue stroma moderately infiltrated by lymphoid and plasma cells. Some areas presented a normal striated musculature and many islands of normal mucous glands. Adjacent to the latter areas, embedded in the dense connective tissue, invading and partially destroying the musculature were partly solid, partly alveolar cords of small epithelial cells. The epithelial cords were markedly irregular and compressed by the surrounding connective tissue. Many of the cords revealed successful attempts to form irregular acini. The acini contained a light blue-staining mucoid material. The small cells had small hyperchromatic nuclei and varied greatly in size and shape. Many were round or oval. Atypical mitoses were not noted.

Sections from the various lobes of the lungs were similar in appearance. Irregular nodules composed of cords of epithelial cells similar to those described were lying in a connective tissue stroma about the larger blood vessels and bronchioles. These cords irregularly invaded the adjacent edematous pulmonary parenchyma. There was a far greater tendency to form acini, with greater quantities of mucoid material in the various nodules.

The pathologic diagnosis was adenocarcinoma arising from the mucous glands of the palate with pulmonary metastases.

In this case are presented clinical as well as histologic criteria of malignant tumor of the mucous glands of the palate, in contrast to the only other cases reported in the literature as adenocarcinoma of the palate, by Ribbert, Boenninghaus, Coenen and others. When first seen, the patient already had a perforated ulcerating lesion of the palate with roentgenologic evidence of pulmonary metastases and clinical evidence of metastases to the cervical lymph nodes. These findings were substantiated at autopsy. The rapid course of the disease also is of significance. The growths reported as adenocarcinoma by the authors cited all began as large masses in the palate covered by normal mucous membrane, were usually of years' duration and did not recur after excision, and the reports do not indicate whether metastases ever occurred. Histologically these growths resemble those originally described by Billroth as cylindroma or by the French observers as "adenome."

#### SUMMARY

A case of adenocarcinoma of the palate arising from mucous glands with metastases to the cervical lymph nodes and the lungs is presented. Search of the literature failed to discover a report of a case of a metastasizing tumor of this character.

## RELIEF OF NEURITIS OF EIGHTH CRANIAL NERVE WITH VITAMIN B<sub>1</sub>

K. C. BRANDENBURG, M.D., LONG BEACH, CALIF.

Among recent therapeutic agents which are showing startling successful results in conditions which have hitherto responded to treatment slowly or not at all, synthetic vitamin B<sub>1</sub> deserves closer attention than it is receiving in the field of ophthalmology and otorhinolaryngology. My purpose in presenting this case report is to direct attention to the possibilities of this new form of therapy, in the hope that its application may be extended to other conditions in which it is likely to prove of benefit.

F. H. Lewy called attention to the fact that the basic factor common to most, if not all, neuropathies, whether they are due to diabetes; pregnancy; alcoholism; hunger; cachexia; pernicious anemia; poisoning with heavy metals, such as lead, mercury, manganese, bismuth, antimony or chromium; metalloid poisoning with arsenic or phosphorus; poisoning with carbon disulfide; infectious diseases, such as yellow fever, typhus, typhoid and paratyphoid, diphtheria, tuberculosis and leprosy, or some constitutional hereditary conditions, is probably a lack of vitamin B.<sup>1</sup> Wechsler substituted the term neuropathy for neuritis, since the histologic changes observed in all these metabolic, toxic and infectious conditions are not those of exudative inflammatory leukocytic infiltration but are the characteristic cloudy swelling and ballooning of the medullary sheath, coil formation of the axis-cylinder and finally granular disintegration, which are also observed in experimental deprivation of vitamin B<sub>1</sub>. The process is one of a failure of normal restoration and repair rather than of inflammation.

Since vitamin B is an essential factor in the metabolic chain by which carbohydrates are made available for the complete oxidation of fats, lack of this vitamin ultimately results in acidosis. Lewy stated that the pathologic changes in the nerves may be considered a peptinization, probably resulting from this increasing acidification. In general, the disturbance of normal function may be summarized as follows:

The liver, which is the main storehouse of vitamin B, is affected by the various noxious agents associated with the metabolic, toxic and infectious conditions mentioned and is rendered unfit for storage purposes. When for any reason the mobile supply of vitamin B in the liver is depleted by one third, the fixed supply in the nervous system is drawn on, and symptoms appear. Four fifths of the supply of vitamin B in the liver can be depleted in one week on a diet free of that substance. Thus the importance of a constant and adequate supply of vitamin B becomes apparent.

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Read before the Eye and Ear Section of the California Medical Association, Del Monte, May 2, 1939.

1. Lewy used the term vitamin B to designate the vitamin B complex and did not differentiate between the various elements in his discussion.



When the average civilized diet is considered in the light of its vitamin B<sub>1</sub> content, it suggests a deliberate conspiracy to create a lack of this vitamin. To give a rough idea of the situation, I shall cite Cowgill's figures comparing the vitamin B<sub>1</sub> contents of various foods. The value of 1 mg. of synthetic thiamin chloride being regarded as 1,000, which is considered an adequate daily intake under ordinary conditions, polished rice rates 1.6, unpolished rice 20, white bread 2, whole wheat bread 20, refined cane sugar 0.00 and cane molasses 150. Thus it may be seen that the use of white flour, polished rice and refined cane sugar deliberately removes much of the vitamin B<sub>1</sub> from its richest natural sources in the diet. With the exception of liver, a few varieties of nuts, wheat germ and yeast, there are no other foods rich in this most essential element. It becomes apparent that the likelihood of a deficiency of vitamin B<sub>1</sub> is not as remote as might be imagined, and an explanation for many vague pains and aches, as well as stubborn attacks of severe neuralgia, emerges.

Lewy called attention to the fact that loss of hearing, nystagmus and visual symptoms suggestive of retrobulbar neuropathy are common in many of the diseases which have been enumerated. As these symptoms are a frequently baffling occurrence in the experience of every specialist in ophthalmology and otology, the importance of this new development in therapy is obvious. Since my interest was awakened in this subject by my own experience, I find that much significant and valuable work, which has not yet been reported in the literature, is being done by a number of physicians. Borsook, of the California Institute of Technology, is getting excellent results in cases of tic douloureux with intravenous administration of thiamin chloride. Dr. Guggenheim, of Los Angeles, is soon to report his results in the treatment of nerve deafness with thiamin chloride. As with sulfanilamide, every day seems to reveal new indications for the use of thiamin chloride.

#### REPORT OF A CASE

The patient was referred to me in April 1938 because of severe bilateral tinnitus, which had begun three weeks previously, about three days after the last of a series of twenty-eight daily roentgen treatments of 303 r each and one exposure to radium of 5,760 milligram hours for an epidermoid carcinoma of the cervix uteri. The onset of the tinnitus was accompanied by severe pain in the cervical and upper lumbar regions of the back and a bandlike headache above the eyes and ears. Some impairment of hearing also was noted. The tinnitus in the right ear was described as being of three separate types, a screeching noise, a scraping noise and a pulsating noise synchronous with the heart beat. The tinnitus in the left ear was more intense than that in the right ear and was described as being like a fog horn, which persisted for a varying number of seconds, stopped for a second and then started again.

Examination revealed both tympanic membranes normal except for some moderate retraction of the left drum. Both eustachian tubes were readily politzerized, without any noticeable effect on the tinnitus. The hearing was charted on the Maico audiometer and an impairment which was most marked in the right ear and in the higher frequencies noted.

The patient had been unable to get a night's sleep with the help of a 6 grain (0.39 Gm.) dose of sodium amytal and was threatening to jump off the pier unless she got relief. The responsibility was mine. I must admit, that in the face of my

previous experience with severe tinnitus not referable to a disturbance in the middle ear, I was not optimistic about my ability to help her.

I recalled, however, a report given by Charles Martin at the Congress of Radiology in Chicago in 1937 concerning the treatment of radiation sickness with vitamin B and also some work that has been done in the relief of alcoholic polyneuritis by Strauss, Wechsler, Joliffe and Colbert. If the condition were neuritis of the eighth nerve resulting from the toxic absorption following the destruction produced by the extensive radiation, perhaps similar therapy would be of value. It was worth a trial, especially in the absence of any other promising form of treatment.

The treatment was therefore started with a daily dose of 10 mg. of thiamin chloride administered intravenously for two days, without any noticeable effect. The dose was raised to 15 mg. on the third and fourth days, and on the fifth day a marked decrease in the tinnitus was first noted. The daily dose of 15 mg. was continued until the ninth day, at which time the tinnitus had stopped in the left ear but still persisted in the right. The following day it was gone in both ears, and it has never recurred since. The audiogram showed a 5 to 40 decibel improvement in hearing, which may possibly have been due either to the absence of the masking effect of the tinnitus or to an actual improvement in the condition of the eighth nerve. There were no subjective symptoms of vestibular involvement. It is not impossible that the normal recovery from the radiation sickness might have played some part in the picture. However, in view of the experience of others with this type of treatment and the good theoretic background for the belief that lack of vitamin B<sub>1</sub> is common to many, if not most, neuropathies, I believe that the intravenous administration of thiamin chloride is a safe and logical method of dealing with similar manifestations in the field of ophthalmology and otology, and I recommend it to the attention of practitioners of these specialties.

Parenteral administration is desirable in order to produce a rapid saturation and because a neuropathy of the vagus nerve, according to M. Bielschowsky, may have resulted in inactivity and even atrophy of the glands of the gastric mucosa, interfering with normal digestion and absorption from the gastrointestinal tract.

Thiamin chloride may be given subcutaneously, intramuscularly, intravenously or even intrathecally with a wide margin of safety, doses of from twenty-five to fifty thousand times the average daily requirement being necessary to produce lethal effects.

An adequate supply in the diet should be assured at the end of the parenteral treatment to prevent a recurrence of the symptoms. This varies from approximately 50 international units for children to 300 for adults, 1 mg. of thiamin chloride being the equivalent of 330 international units.

#### SUMMARY

1. A case of severe bilateral tinnitus and impairment of hearing following extensive radiation therapy for carcinoma of the cervix uteri is reported in which relief was obtained by daily intravenous injection of thiamin chloride in 10 and 15 mg. doses for nine days.

2. Intravenous administration of thiamin chloride in one or more daily doses of 10 mg. for all neuropathies of the cranial nerves is suggested and its possible mode of action indicated.

# Abstracts from Current Literature

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## Ear

OTITIS MEDIA FROM THE PAEDIATRICIAN'S VIEWPOINT. G. A. CAMPBELL, Canad. M. A. J. 40:146 (Feb.) 1939.

Campbell advises local treatment with chlorbutanol, ephedrine, glycerin and water for twenty-four to forty-eight hours in the average case of otitis media. If improvement has not been observed by that time, he advises myringotomy.

If the condition is in the acute stage, sulfanilamide is used and has been found effective in shortening the course of otitis and preventing complications involving the mastoid. A concentration of 4 mg. per hundred cubic centimeters of blood is maintained.

Toxic symptoms are rare.

During 1936 and 1937 the average number of days of hospitalization in cases of otitis was twenty-four and fifteen hundredths and the incidence of complications 8.2 per cent. During 1937 and 1938, with routine use of sulfanilamide, the average duration of hospitalization was reduced to eight and seven hundredths days and the incidence of complications to 4.1 per cent.

Campbell stresses the importance of latent mastoiditis as a cause of fatal marasmus; 53 per cent of all children who died in the hospital showed purulent mastoiditis at autopsy.

MOORE, Omaha. [AM. J. DIS. CHILD.]

SULFANILAMIDE IN THE TREATMENT OF OTITIS MEDIA. GILBERT E. FISHER, J. A. M. A. 112:2271 (June 3) 1939.

Fisher reports striking results of the use of sulfanilamide in the treatment of acute otitis media due to the beta hemolytic streptococcus. In 95 cases sulfanilamide was not given, while in 88 cases it was given with an equal amount of sodium bicarbonate. In all these cases the red protruding drum membrane was incised, or, when spontaneous perforation took place, incision to enlarge the opening was performed in order to promote drainage. In the study, as arranged in tabular formation, it is seen that the numbers of patients receiving sulfanilamide and of those not receiving it were about equal for each month. No seasonal variation or difference due to the virulence of the infecting organism is apparent in this series. The months of December, January, February and March showed a larger incidence of aural suppurations.

The actual difference in treatment in the cases in this series is merely the use of sulfanilamide in one group and not in the other, and because of the care with which the study was conducted the results speak emphatically for themselves.

Of the 95 patients who had myringotomy but were not given sulfanilamide, 66 required mastoidectomy, whereas of the 88 patients who had myringotomy and were given sulfanilamide, only 7 required mastoidectomy. Four of the group not receiving sulfanilamide had septicemia; 3 of these recovered after operation, and 1 died.

No complications arose in the group of 88 patients who received sulfanilamide. The average duration of otorrhea for 95 patients who did not receive sulfanilamide was sixty-five days, while the otorrhea of the 88 patients who were given sulfanilamide lasted on the average twenty-three days.

The author has found 10 grains (0.65 Gm.) of the drug (with an equal part of sodium bicarbonate) three times daily for the first four days and 5 grains (0.32 Gm.) three times daily thereafter safe and effective.

The toxic symptoms that should be looked for and the undesirable effects of the drug are as follows: (1) increasing weakness and lassitude; (2) loss of appetite; (3) nausea and vomiting; (4) fever, which decreases when the drug is withdrawn and increases when its administration is begun again; (5) a progressive fall in hemoglobin; (6) dermatitis, especially of the exfoliative type; (7) severe hemolytic anemia with jaundice, at the appearance of which administration of the drug should be discontinued and a transfusion given, and (8) agranulocytosis.

When any of the first four symptoms appear, administration of the drug should be reduced or discontinued entirely. When any of the last four symptoms appear, administration should be discontinued at once.

GORDON, Philadelphia.

THE DEAFNESS OF VAN DER HOEVE'S SYNDROME IS DEPENDENT ON STAPEDO-VESTIBULAR ANKYLOSIS. P. MOUNIER-KUHN, *Oto-rhino-laryng. internat.* **23**: 57 (Feb.) 1939.

This article is concerned with the otologic examination of a father and daughter with a heredity of van der Hoeve's syndrome. In both, the examinations revealed a negative reaction to the Rinne test, prolonged perception in the Schwabach test, lateralization of sound to the most affected ear in the Weber test, paracousis, normal reactions to the Gellé and Jacod tests and raising of the lower tone limit. The drum membrane was rosy and hypermobile, and the patients suffered with continuous tinnitus. Thus, the diagnosis was clearly otospongiosis.

It cannot at present be assumed, however, that the two diseases are identical; it can only be said that they are akin.

DENNIS, San Diego, Calif.

ASYMPTOMATIC THROMBOSIS OF THE LATERAL SINUS OF OTITIC ORIGIN. C. CALABRESI, *Arch. ital. di otol.* **51**:129 (March) 1939.

Calabresi reports on 2 patients who had thrombosis of the lateral sinus without clinical symptoms. One had subacute otitis; the other, chronic purulent otitis. In the case of the first the thrombosis was discovered in the course of a mastoidectomy, and as it was assumed from the appearance of the sinistral wall that it was a matter of aseptic thrombus, the sinus was not opened. Recovery was uneventful. The second patient did not present symptoms of thrombosis. During the course of a radical exenteration of the mastoid the sinus was uncovered; the wall appearing normal, it was not opened. The patient died within forty-eight hours after operation in a state of cardiac collapse. Autopsy revealed an occluding thrombus in the horizontal portion of the sinus, extending to the beginning of the opposite sinus and the longitudinal sinus. The descending portion contained a parietal clot. Two small openings were observed in the wall of the vessel, and death was attributed to a large subdural hemorrhage. A low grade of microbic virulence was believed to be the cause of the latent progress of the disease.

DENNIS, San Diego, Calif.

CHRONIC SUPPURATION OF THE MIDDLE EAR AND VITAMIN C. F. CHIMANI, *Monatschr. f. Ohrenh.* **73**:123 (Feb.) 1939.

The author found a deficiency of vitamin C in cases of chronic suppuration of the middle ear. Consequently he administered vitamin C in such cases and improved the chronic otitis. Experimental work on guinea pigs revealed that vitamin C could be found in the mucous membrane of the middle ear but not in the mucosa of the nose and the mouth in animals fed with it.

LEDERER, Chicago.

A NEW VIEW CONCERNING THE DIMINUTION OF HEARING IN OTOSCLEROSIS AND POSSIBLY A NEW CONCEPTION OF TREATMENT. M. MEYER, *Monatschr. f. Ohrenh.* **73**:140 (Feb.) 1939.

The typical conduction deafness in otosclerosis is produced not only by fixation of the stapes but also by an increase in pressure within the spaces of the inner ear. Consequently decompression of these spaces by fenestration of the internal ear may be expected to improve the hearing. Meyer attempts to accomplish the same effect by suboccipital (cisternal) puncture. In fact, he succeeded with that kind of treatment in 11 cases. However, it is not possible as yet to say whether or not the effect can be considered permanent. He further calls attention to the fact that the diminution of hearing of high tones in patients with otosclerosis does not indicate degeneration of the cochlea, as in such cases high tones are well perceived by bone conduction.

LEDERER, Chicago.

THE THERAPEUTIC RESULTS IN THIRTY CASES OF OTOGENOUS SEPSIS. D. JOANNOVICH, *Ztschr. f. Hals-, Nasen- u. Ohrenh.* **45**:17 (March) 1939.

In an eight year study of 556 cases of disease of the middle ear, the author observed and analyzed 30 cases of otogenous sepsis. In 18 of these the condition occurred in the course of acute otitis media, and in 12 it followed an acute exacerbation of chronic otitis media. He observed 23 cases of thrombophlebitis, and he noted intracranial complications in 12 cases. The most common organism was the streptococcus (21 cases), with the pneumococcus second (7 cases).

The usual treatment in such cases consisted of operation and removal of the focus of infection, ligation of the jugular vein, serum therapy, blood transfusions, chemotherapy and administration of vaccines. He performed ligation in 28 cases, in which he had 18 cures and 10 deaths. The vein was not ligated in 2 cases, in 1 of which the patient died. In 12 of the 21 cases of streptococcal infection treatment with Vincent's antistreptococcus serum was instituted. In these, he had 11 cures and 1 death. In the remaining 9 cases, there were 5 deaths and 4 cures. In the 7 cases of pneumococcal infection, he had 4 deaths and 3 cures, and he concludes that the pneumococcal infection always presents a much graver prognosis.

In view of the favorable results with Vincent's antistreptococcus serum, he suggests that it be recommended routinely in all cases of streptococcal infection. It can be given intramuscularly, subcutaneously or intravenously. The intravenous doses averaged from 15 to 60 cc., the intramuscular from 20 to 100 cc. and the subcutaneous injection from 5 to 60 cc. The maximum daily dose was 180 cc. and the minimum 30 cc.

In conclusion, he repeats that in 30 cases of operative otogenous sepsis he had 19 cures and 11 deaths, and he stresses the value of combining antistreptococcus serum with the usual therapy.

PERSKY, Philadelphia.

TRANSITORY VESTIBULAR DISTURBANCES, WITH A CONSIDERATION OF THE USE OF FRENSEL'S GLASS. J. OHM, *Ztschr. f. Hals-, Nasen- u. Ohrenh.* **45**:22 (March) 1939.

The author presented the case of a patient with transient vertigo of four days' duration and vomiting for the last two days.

Observations at general examination were essentially negative except for nystagmus, which the author measured with a nystagmograph. He noted that the nystagmus was weaker in a bright light, and hence he darkened the room, and in addition he used Frensel's glasses. By these procedures, he was able to determine that the patient had a lesion on the left side, either in the nerve or in the nucleus.

In conclusion, he suggests that the nystagmograph be used in all cases, particularly in those in which there are either transient or fine ocular movements, which are difficult to perceive or elicit. In addition, he suggested the use of a dark room and the Frensel glasses to aid in the determination of these minimal or evanescent signs.

PERSKY, Philadelphia.

ANALYSIS OF SIXTY-ONE CASES OF THROMBOSIS OF THE LATERAL SINUS OF OTITIC ORIGIN OBSERVED DURING FIFTEEN YEARS AT THE IMPERIAL UNIVERSITY HOSPITAL, OKAYAMA. SHIGERO TAKAHARA, SADAKUNI OKA and KINJIRO OHNO, *Ztschr. f. oto-rhino-laryng.* **45:42** (Jan.) 1939.

A comparative study of the mortality in cases observed during 1921 to 1931 and in those observed during 1931 to 1936 is given.

1. There were 61 cases of sinus thrombosis during the fifteen years.
2. One thousand, five hundred and seventy-nine mastoidectomies were performed, an incidence of 3.9 per cent of thrombosis of the lateral sinus.
3. Other intracranial complications were meningitis in 60 cases and abscess of the brain in 15.
4. In 42 of the 61 cases, or 68 per cent, the patient made a full recovery.
5. Thirty-seven patients were male and 24 female; 12 were under 15 years of age, 30 between 15 and 50 years, and 18 above 50.
6. In 42 of the cases the condition originated from acute infection, in 28 of which, or 66 per cent, the patient recovered, and in 19 it originated from chronic infection, in 14 of which, or 73.6 per cent, the patient recovered.
7. The condition affected the right ear in 32 cases (chronic in 7 and acute in 25) and the left ear in 29 (chronic in 12 and acute in 17).
8. Metastasis occurred in 11 cases, in 4 of which the patient recovered.
9. The site of thrombosis was at the sinus transversus in 38 cases, at the sinus transversus and the bulb in 9 cases, at the bulb and the internal jugular vein in 1 case and at the sinus transversus, the jugular bulb and the internal jugular vein in 11 cases.
10. During the last five years the rate of recovery was 75.8 per cent, an increase from the 62.5 per cent of the previous ten years.

The authors attribute their success to the following measures:

1. Employment of Queckenstedt's test for early recognition of thrombosis. They consider that the difference of 50 mm. in the pressure of the spinal fluid between the two ears is indicative of the involvement of the venous channel.
2. Early ligation of the internal jugular vein when any of the following indications is noted:
  - (a) Signs of metastasis.
  - (b) Extension of the thrombosis into the internal jugular vein.
  - (c) Failure of organization of the thrombus in the lateral sinus or in the bulb.
  - (d) Persistent septic temperature after closure of the lateral sinus.

HARA, Los Angeles.

CONTINUOUS IRRIGATION OF THE SPINAL FLUID FOR MENINGITIS OF OTITIC ORIGIN. KIYOSHI SHIMIZU, *Ztschr. f. oto-rhino-laryng.* **45:381** (March) 1939.

In a 10 year old boy acute meningitis developed as a complication of chronic mastoiditis of several years' duration. Study of the spinal fluid indicated strongly positive Nonne-Apelt and Pandy reactions. There were 2,201 cells, mostly polymorphonuclear, though culture did not show growth and Queckenstedt's sign also was negative.

On the evening of admission to the hospital radical mastoidectomy was performed. This was followed by continuous irrigation of the spinal fluid. For hydration the patient received 700 cc. daily of Locke's solution, both subcutaneously and intravenously, in addition to methenamine, 4 Gm. daily, in the vein. After this treatment the signs of meningeal irritation gradually subsided, and on the seventeenth postoperative day spinal irrigation was suspended. With the reappearance of untoward signs the irrigation was reestablished and continued until the cell counts became normal, which occurred on the fifty-seventh postoperative day.

The patient was dismissed on the seventy-third postoperative day. The irrigations were interrupted twice, for five and for three days, during the observation. The average amount of spinal fluid removed daily was 312 cc., the total in forty-six days 14,350 cc.

HARA, Los Angeles.

## Pharynx

TONSILLECTOMY UNDER INTRAVENOUS ANAESTHESIA IN CHILDREN SUFFERING FROM CHRONIC RESPIRATORY DISEASES. K. HUTCHISON, H. S. MITCHELL and H. McHUGH, *Canad. M. A. J.* **39**:237 (Sept.) 1938.

Twenty-two cases are reported in which intravenous anesthesia was used. Pentothal sodium was used in the first group of cases and evipal in the later, larger group. In a few cases of the latter group morphine was used preoperatively.

The average dose of pentothal sodium employed amounted to 0.608 Gm., while of evipal 0.614 Gm. was employed. The average age of the patients was 8.9 years; the youngest patient was 3 years old and the oldest 16.

Intravenous anesthesia may be of value in selected cases, but the authors do not feel that it should displace the ordinary methods for healthy children.

MOORE, Omaha. [*AM. J. DIS. CHILD.*]

RETROPHARYNGEAL ABSCESS. C. W. EVATT, *J. South Carolina M. A.* **34**:287 (Nov.) 1938.

Retropharyngeal abscess may be acute or chronic. The chronic abscess is a tuberculous condition and usually is associated with Pott's disease or tuberculosis of the cervical glands. It is not discussed in this paper. Acute retropharyngeal abscess is usually caused by a streptococcus. At Roper Hospital in Charleston, S. C., the author reviewed cases of this disease in 4 adults and 8 children (3 under 1 year of age). The incidence was distributed equally between the sexes. The onset may be slow or rapid and is associated with tonsillitis. The condition should be diagnosed early and treated immediately with incision. It is best to have a tracheotomy outfit ready for use if necessary.

WESTON, Columbia, S. C. [*AM. J. DIS. CHILD.*]

BIOLOGIC SIGNIFICANCE OF THE TONSILS AND ADENOIDS AND OTHER EXTERNAL LYMPHOID MASSES. P. W. LEATHART, *Brit. M. J.* **2**:835 (Oct. 22) 1938.

This is a discussion along the lines indicated in the title. In general, it is a plea for conservatism in respect to the tonsils and adenoids. Leathart concludes:

"1. That the function of an external lymphoid mass is to collect micro-organisms from food or air and to grow those to which an immunity is needed.

"2. That the condition 'enlarged tonsils' alone is definitely an indication against their removal.

"3. That the adenoid facies is more commonly caused by catarrhal sinusitis than by an adenoid mass.

"4. That catarrhal sinusitis can be treated successfully in a large number of cases without operation, by giving a 'nasal aperient.' [This term refers to a relatively prolonged administration of potassium iodide.—Abstracter.]

"5. That tonsils and adenoids at the present time are removed too frequently and without due consideration of their important biological function.

"6. That many cases of rheumatic fever and acute nephritis that are going downhill can be cured or greatly benefited by removal of the 'carrier organ.'"

ROYSTER, University, Va. [*AM. J. DIS. CHILD.*]

HAEMORRHAGE FOLLOWING TONSILLECTOMY. D. W. ASHCRAFT, Brit. M. J. 2:1078 (Nov. 26) 1938.

The subject is treated under the three following headings:

I. Factors influencing the occurrence of hemorrhage following tonsillectomy: (a) preoperative; (b) operative; (c) postoperative.

II. Types of postoperative hemorrhage.

III. The management of hemorrhage following tonsillectomy.

The preoperative factors influencing the occurrence of hemorrhage following tonsillectomy are as follows:

1. Severe tonsillitis or peritonsillar abscess. Recent infections increase the risk of hemorrhages. Therefore, after the occurrence of one of these conditions, a few weeks should elapse before operation.

2. Infections of the nose or nasal accessory sinuses. Acute sinusitis is a contraindication to immediate performance of the operation, as is the common cold. Chronic sinusitis should not be overlooked. Treatment for this condition should be instituted before tonsillectomy is considered.

3. Bleeding. If there is a history of susceptibility to prolonged bleeding, an investigation should be made before operation. The common coagulation time is four to seven minutes; the bleeding time one to four minutes. If they are prolonged, calcium and alkalis should be given or a blood transfusion performed. If bleeding cannot be controlled, tonsillectomy, unless absolutely necessary, should not be considered.

4. Menstruation. The objection to an operation in this period is based on psychologic considerations rather than on fear of hemorrhage.

5. Jaundice. Tonsillectomy is contraindicated in the presence of jaundice.

6. Anemia. Tonsillectomy should not be performed unless preliminary treatment is given; even a blood transfusion may be advisable.

7. Type of patient. This concerns the adult rather than the child.

The operative factors are now taken up. The type of operation is discussed. Chloroform anesthesia or deep anesthesia induced by any other agent results in a fall of blood pressure. Therefore, when the blood pressure regains its normal level, hemorrhage may occur. Clot formation is liable to be imperfect in the larger veins in the bed of the tonsillar fossa. Especially is this likely to be so when there has been a complete division of a large longitudinal vein. The bleeding point must be searched for and tied. The maintenance of a clear airway is important after tonsillectomy. Hence it is important that an artificial airway be inserted in the mouth after all the blood clot has been removed. One must be certain that all ligatures are securely tied. Vasoconstrictors are not to be recommended for use at the time of operation because of the subsequent reaction of capillary ooze.

The postoperative factors are considered as follows. All conditions tending to cause congestion are to be avoided after the operation. In bed, the patient should be in the "lateral" position. The artificial airway should be removed when the cough reflex has returned. Restlessness after operation calls for a sedative. Children should have an enema containing bromides. No hot fluids are to be permitted during the first twenty-four hours. Cold fluids or semisolid food are given during the first day. The patient should be allowed out of bed for the first time on the evening of the third day following operation. No hot baths are allowed in the first ten days after the operation. For a week after leaving the hospital there must be avoidance of all strenuous exercise. A mixture containing potassium chlorate, sodium salicylate and sodium bicarbonate should be given three times daily throughout convalescence.

The types of hemorrhage are: (1) reactionary hemorrhage occurring within the first twenty-four hours after operation, (2) hemorrhage during convalescence and (3) true secondary hemorrhage. The management of these types is as follows: For the *reactionary ooze* the author prefers morphine in the case of adults and



children over 10 years but bromide and chloral hydrate for children under 10 years. The material on the treatment of reactionary hemorrhage is too extensive to abstract. Hemorrhage during convalescence occurs usually on the fifth night after operation and is due to factors already enumerated. As a rule, it is not severe, and when it is not the author uses a gargle of weak hydrogen peroxide. The clot should not be removed, as it may remove itself after the act of gargling. True secondary hemorrhage is much more serious than the other types. It is also rare. Control of such hemorrhage is difficult in many cases, as it is seldom possible to clamp and ligate a single bleeding point. Recourse to suturing the faucial pillars may be necessary. Other measures which have been recommended are of doubtful value according to the author's experience.

ROYSTER, University, Va. [AM. J. DIS. CHILD.]

## Larynx

ACUTE LARYNGITIS IN INFANTS. G. J. GREENWOOD, Illinois M. J. **75:52** (Jan.) 1939.

Following a review of the anatomy, histology, bacteriology, symptomatology and therapeutics of acute laryngitis in infants, with a discussion of 14 cases observed at the Children's Memorial Hospital during the winter of 1933-1934, Greenwood arrives at the following conclusions: Specific laryngitis in infants is a pertinent pediatric problem. When signs of obstructive dyspnea appear, the endoscopist or the endoscopically trained laryngologist should be summoned. For immediate relief intubation or tracheotomy is necessary. Greenwood believes that in an infant low tracheotomy conserves the laryngeal structure better than intubation.

BARBOUR, Peoria, Ill. [AM. J. DIS. CHILD.]

CHORDECTOMY BY MEANS OF SURGICAL DIATHERMY. T. DEMETRIADES, Monatschr. f. Ohrenh. **73:119** (Feb.) 1939.

The writer removes tumors of the vocal cords by means of the electrical knife. The advantage of this procedure is supposed to be the avoidance of postoperative hemorrhages.

LEDERER, Chicago.

THE PATHOLOGIC HISTOLOGY OF LARYNGEAL TUBERCULOSIS. H. ESCHWEILER, Ztschr. f. Hals-, Nasen- u. Ohrenh. **45:31** (March) 1939.

The author discusses the different modes of tuberculous infection of the larynx and presents sections from cases wherein the hematogenous route may be a factor. He believes that primary infection of the larynx is rare, even in cases in which a pulmonary lesion is not demonstrable. In discussing the involvement of the regional lymph glands, he states that it varies in degree in laryngeal tuberculosis, because of the paucity of the lymphatic system about the intrinsic larynx, where one finds but few glands, while, on the other hand, an infection of that portion of the larynx which is richly supplied by a lymphatic system, such as the introitus of the larynx and the sinus piriformis, can be drained by the glands in the membrana hyothyreoidea and carried to the superior cervical glands and then to those about the common facial vein and the internal jugular vein. However, in cases of the latter type, one must be careful to eliminate a descending infection from the tonsils. The author has also presented a specimen in which he was able to trace a tuberculous infection from the entrance of the larynx and the sinus piriformis to the glands and the membrana hyothyreoidea.

In the incipient stage of the infection there is a marked exudative reaction and a distortion of the involved structures, with a subsequent marked invasion of the lymphatic system. However, in a secondary or later stage, immunity is established in the lymphatic system. In the tertiary stage, there is often evidence of an exudative and a productive process. The author believes that the edema of

the larynx is really a stasis, particularly in a chronic form. In the acute form, he states, the edema may result from some toxic influences on the walls of the blood vessels.

In conclusion, he believes that the symptoms must be carefully correlated with the histologic picture for an accurate evaluation of the underlying process.

PERSKY, Philadelphia.

## Nose

OSTEOMYELITIS OF THE SPHENOID BONE—REPORT OF FIVE CASES WITH THE AUTOPSY FINDINGS. HOWARD C. BALLENGER, *Ann. Otol., Rhin. & Laryng.* 48:95 (March) 1939.

Ballenger discusses, briefly, the reports of osteomyelitis of the sphenoid bone and mentions that sphenoid sinusitis is responsible for about 35 per cent of all intracranial complications of nasal origin. The spread of the infection to the meninges was found to be predominantly vascular, particularly via the sphenoid mucosa and through the vascular marrow spaces of the sphenoid. He feels that in at least a vast majority of cases there must of necessity have been some form of osteomyelitis. The etiologic factor in most cases seems to have been preceding sphenoiditis, although the possibility of retrograde thrombophlebitis from the cavernous sinus or an extension from petrositis must be borne in mind. Rarely thrombi or bacteria from a distant focus may lodge in the vascular spaces of the sphenoid. Diagnosis of osteomyelitis of the sphenoid before the occurrence of intracranial complications is difficult. The usual signs of sphenoiditis are usually present. Signs of sepsis appear as bone is involved, but localizing signs are absent. Roentgen examination may show a cloudy or vague outline of the sphenoid wall. This increased density may extend into the middle fossa or along the base of the skull. The sella may show changes associated with osteitis or osteomyelitis. Pfahler says that the sella may show calcification of the bridge or ligaments connecting the anterior and posterior clinoid processes. Calcification, or a flocculent deposit of lime, may be seen in the bands behind the posterior processes. The organisms usually found are *Pneumococcus* type III and the hemolytic streptococcus. The most frequent complication of osteomyelitis of the sphenoid is meningitis and next thrombosis of the cavernous sinus. He reports 5 cases of osteomyelitis of the sphenoid.

M. V. MILLER, Philadelphia.

THE TREATMENT OF RHINITIS CHRONICA HYPERPLASTICA. BAER, *Monatschr. f. Ohrenh.* 73:108 (Feb.) 1939.

The writer uses endonasal instillations of 50 to 60 per cent solutions of dextrose for the treatment of rhinitis chronica hyperplastica and reports good results.

LEDERER, Chicago.

AN INSTRUMENT FOR THE OPENING OF THE MAXILLARY SINUS THROUGH THE INFERIOR MEATUS. W. HAARDT, *Monatschr. f. Ohrenh.* 73:110 (Feb.) 1939.

The author has constructed a new instrument for the opening of the maxillary sinus through the inferior meatus. As he does not illustrate the instrument it is difficult to judge its practical importance and originality. LEDERER, Chicago.

A CONSIDERATION OF THE RADICAL OPERATION ON THE FRONTAL SINUS (SEIFFERT'S MODIFICATION). K. WÜRFEL, *Ztschr. f. Hals-, Nasen- u. Ohrenh.* 45:46 (March) 1939.

Würfel discusses various types of radical operations on the frontal sinus—Kuhnt's, Jansen's, Riedel's and Killian's—and he also outlines their limitations. In view of these, he recommends as an operation of choice the Seiffert modification of the Killian operation.

His technic is as follows: After the completion of the Killian operation and just prior to the suturing of the skin, he makes sure that there is a wide nasofrontal communication. He inserts a rubber-covered tampon through the nose into the frontal sinus. Along with this tampon is usually a small drainage tube to take care of any mild drainage from the sinus. At the upper end of this tampon, he has previously placed a layer of Thiersch skin graft. This flap extends into the frontal sinus, with its superior surface placed so that it covers the supra-orbital ridge and approximates the suture line. The flap must be large enough to extend from the septum to the supraorbital ridge and then upward to the edge of the sinus. The outer skin is then sutured, and a pressure bandage is applied externally. Four to seven days after the operation, the nasal pack or tampon is removed.

The author analyzed a series of 136 cases in which operation was done by this method between the years 1923 and 1934. In this group, he was able to follow up 72 patients. The results were striking in that after five years he was able to maintain a widely patent nasofrontal opening; the resultant scar was scarcely noticeable; the external deformity was negligible, and, because of the thoroughness, there were few recurrences, which were due either to underlying ethmoiditis or to a recurrent infection of the upper part of the respiratory tract. In this series he had only 13 complications and 11 deaths. Among the complications were meningitis in 2 cases and osteomyelitis in 3.

He recommends this technic because it shortens the convalescence, reduces postoperative complications, minimizes the number of recurrences and maintains a widely patent nasofrontal duct for a long time. Failure of the graft to "take," with secondary necrosis and sloughing, occurred in only rare instances.

PERSKY, Philadelphia.

#### A SOLITARY OSTEOMA OF THE ETHMOID LABYRINTH EXTENDING INTO THE ORBIT.

WILHELM SCHOLZ, *Ztschr. f. Hals-, Nasen- u. Ohrenh.* 45:86 (March) 1939.

A case of osteoma of the ethmoid labyrinth which extended into the orbit in a 16 year old patient is reported. The patient had not complained of any previous symptoms referable to the nose or throat, but had noticed that for the past two to three years the eyes were slowly distorted outward and forward. Pain, disturbance of vision or interference with breathing did not occur.

Examination revealed a hard crescentic swelling on the nasal wall of the orbit. Roentgen examination revealed a massive shadow extending into the right orbit, irregular in outline but sharply defined, with a pedicle extending into the right ethmoid labyrinth.

At operation, the author found a hard white tumor, which was freely outlined and was attached to the ethmoid labyrinth by a short pedicle. He was able to remove the wall of the labyrinth without laceration of its mucous membrane. The patient recovered without any untoward events during convalescence.

Histologic examination showed the tumor to be a fibro-osteoma.

PERSKY, Philadelphia.

#### FIVE CASES OF EXOPHTHALMOS CAUSED BY ETHMOIDITIS. AKIRA NAKANO and KAZUO SATO, *Oto-rhino-laryng.* 12:105 (Feb.) 1939.

The authors report 5 cases of ethmoiditis with symptoms referable to the eye, especially exophthalmos. They review the manner in which the pathologic changes occurred.

CASE 1.—A man aged 49 gave a history of chronic ethmoiditis on the right associated with frontal headache, double vision, photophobia and impairment of hearing and vision of about a year's duration. A Denker operation was followed by intranasal ethmoidectomy. Within a week after the operation the vision was restored, and the exophthalmos gradually disappeared.

CASE 2.—A woman 49 years old presented a strongly positive Wassermann reaction with a history of ethmoantritis on the left of seven years' duration. Three months previously she had had a cold associated with headache, impairment of vision and exophthalmos on the left. After transantral ethmoidectomy, the vision was greatly improved, and the exophthalmos completely disappeared.

CASE 3.—The patient was a boy 8 years old.

CASE 4.—In a woman 28 years old exophthalmos developed shortly after she had taken a cold. At the time of external ethmoidectomy, slight change other than hyperemia of the mucosa was noted in the ethmoid capsules. The exophthalmos disappeared after the operation.

CASE 5.—A man aged 35 had had a bilateral Caldwell-Luc operation twenty years before. About three years before coming under observation he noticed impairment of vision which was associated with exophthalmos on the right side which gradually became worse. At external ethmoidectomy a large mucocele was disclosed. Ten days after the operation, the vision was recovered, and the exophthalmos became almost unrecognizable. The article is well illustrated with photographs of the patients and roentgenograms of their paranasal sinuses.

HARA, Los Angeles.

### Miscellaneous

ACUTE BULBAR POLIOMYELITIS FOLLOWING RECENT TONSILLECTOMY AND ADENOID-ECTOMY. M. STILLERMAN and A. E. FISCHER, *Am. J. Dis. Child.* **56**:778 (Oct.) 1938.

Stillerman and Fischer studied the 686 patients with poliomyelitis who were admitted to the Willard Parker Hospital during 1935, in order to determine whether the removal of tonsils and adenoids in any way influenced the onset or clinical type of the disease. It was found that tonsillectomy and adenoidectomy had been performed in 10 cases during the month antedating the illness. In 8 of these cases poliomyelitis began from ten to twelve days, and in the other 2 cases, sixteen and twenty-two days, respectively, after the operation. Six of 10 patients had the bulbar or encephalitic form of the disease. Careful inquiry was made among 52 patients with poliomyelitis who were admitted to the hospital during 1937. On 3 of these patients tonsillectomy had been performed from two to three weeks preceding the onset of poliomyelitis. These 3 children had the bulbar type of the disease. All of them died. The bulbar or encephalitic type of poliomyelitis was present in 68 of the 686 patients and in 15 of the 52 patients, while in 6 and 3 patients, respectively, who recently had had tonsils and adenoids removed the bulbar or encephalitic type developed. Thus, there was a disproportionately high percentage of bulbar involvement among the tonsillectomized patients in both the 1935 and the 1937 outbreak. This much higher incidence of bulboencephalitic forms suggests the operative field as the port of entry of the virus. The authors conclude, therefore, that tonsillectomy and adenoidectomy should not be encouraged during an epidemic of poliomyelitis.

AUTHORS' ABSTRACT. [*ARCH. NEUROL. & PSYCHIAT.*].

CERTAIN THERAPEUTIC EFFECTS OF WHOLE SUPRARENAL GLAND BY MOUTH. O. E. BARBOUR, *Arch. Pediat.* **55**:661 (Nov.) 1938.

Over 380 patients are included in this study. Desiccated whole adrenal gland was administered to infants or children of the allergic or vagotonic type. The optimal dose seemed to be 1 grain (0.064 Gm.). If the conditions treated were acute, the substance was administered at two or three hour intervals.

One hundred and forty children with bronchial asthma were treated, and relief was obtained by 74 per cent. The adrenal gland seemed to assist in the cure of 32 of these children.

Forty-four patients with spasmodic croup were treated, and relief was obtained for 90 per cent.

Eighty infants suffered from pylorospasm; vomiting was relieved for 90 per cent. For those who did not improve within one or two days, adrenal gland was augmented with iodine or thyroid gland, a procedure which usually produced the desired results.

Eighty patients with eczema were treated, and adrenal gland was effective, alone or when administered with iodine or thyroid gland, in relieving 80 per cent. Improvement was prompt, usually occurring within one or two days. When the optimal dose was established and maintained, the skin remained free from the rash in 80 per cent of the patients. Food allergy presented no great problem when endocrine therapy was employed.

In treating 40 patients with hypothyroidism, adrenal substance proved most valuable when used in conjunction with thyroid substance. More adequate amounts of thyroid could be administered when adrenal material was administered than when thyroid was given alone.

For purposes of comparison and as partial controls, treatments other than that with desiccated adrenal gland were given alternately or concomitantly at intervals through the course of this study. Drugs which simulated the therapeutic action of adrenal gland were ephedrine and neosynephrin.

Iodine and atropine reacted to the adrenal therapy much as did thyroid gland. They appeared to inhibit the untoward reactions and at the same time to enhance the effectiveness of the therapy. In some patients untoward reactions occurred while adrenal gland was being administered, such as abdominal pain, vomiting and constipation.

ORR, Buffalo. [AM. J. DIS. CHILD.]

#### TREATMENT OF ACUTE INFECTIONS OF THE CENTRAL NERVOUS SYSTEMS WITH SULFANILAMIDE. J. B. NEAL, J. A. M. A. **111**:1353 (Oct. 8) 1938.

Neal reviews the mortality statistics of large series of cases of meningitis. The various virulent and bacterial types are mentioned, as well as the effect of sulfanilamide on each. The most remarkable change has been the reduction in the mortality from meningitis due to *Streptococcus haemolyticus* from over 95 per cent to 20 per cent in 27 cases. Some reduction occurred in the incidence of meningococcic meningitis; little, in that of pneumococcic meningitis and the other types. Drainage of the focus of infection is essential.

HEERSMA, Kalamazoo, Mich. [AM. J. DIS. CHILD.]

#### SULFANILAMIDE IN TREATMENT OF BRAIN ABSCESS AND PREVENTION OF MENINGITIS. P. C. BUCY, J. A. M. A. **111**:1639 (Oct. 29) 1938.

Bucy reports a case in which an abscess of the brain was cured and a condition which was almost certainly meningitis due to hemolytic streptococci prevented by the administration of sulfanilamide. Owing to an error in diagnosis, a cerebellar abscess on the right was exposed with bilateral suboccipital craniectomy. The contents of the abscess were aspirated, and the surface of the cerebellum was contaminated with pus swarming with hemolytic streptococci, the ventricular system and the subarachnoid space being thus exposed to this infection. The abscess was not drained. The administration of sulfanilamide was begun at once. The patient improved steadily. There was almost no febrile reaction, and at no time did signs either of meningitis or of refilling of the abscess develop. The patient had almost completely recovered within two weeks.

EDITOR'S ABSTRACT. [ARCH. NEUROL. & PSYCHIAT.]

TOPOGRAPHIC SYNDROMES OF THE CENTRAL VESTIBULAR PATHWAYS IN MAN.  
J. A. BARRÉ, Rev. d'oto-neuro-opht. 16:420 (June) 1938.

This article is a continuation of Barré's report to the Tenth Congrès des Sociétés d'Oto-Neuro-Ophtalmologie. The first part was published in the May 1937 issue of *Revue d'oto-neuro-ophtalmologie* (page 321).

In order to clear up misunderstandings of the terms "deficit" and "irritation," Barré defines them as follows: By deficit, as applied to a nerve pathway, is meant absence, disturbance or diminution of conduction and the disturbances resulting from it. For the vestibular apparatus, a deficit would be shown by disturbance or lack of sensation or reflex, in whole or in part, in the distribution of its components. The term irritation implies a redoubling of physiologic activity; this activity is abnormal because of its degree or duration. The phenomena of deficit and irritation may coexist in a large number of pathologic conditions. In certain other cases each may appear in a pure state. They are common to the central and the peripheral neurons. That a lesion may have a double effect is proved by the frequent observation of a case in which conduction is arrested in the peripheral neuron by a lesion that at the same time is the source of abnormal excitation of the central neuron. Certain lesions produce particularly the signs either of deficit or of irritation, so that clinical analysis may warrant an opinion concerning the nature of the lesion. An acoustic tumor, of slow development, may exist for years without producing symptoms other than unilateral deafness. Other lesions, developing more rapidly, produce early marked tinnitus, while the hearing is only slightly affected. Barré cites the vestibular disturbances observed in cases of syringobulbia and multiple sclerosis as examples of irritative syndromes. Complex syndromes are produced by lesions that involve both the vestibular apparatus and the cerebellum. Only recently has an attempt been made to analyze separately the syndromes of these two regions. Vestibular hypotonia associated with cerebellar hypotonia causes excessive nystagmus; in the test of the extended arms, however, it may happen that either one or both arms, which would be displaced horizontally in a given direction if the vestibular apparatus alone were involved, remain immobile or deviate to the opposite side if the cerebellum also is involved. The vestibular harmony has been broken by participation of the cerebellum.

The vestibular syndromes may be grouped into a few general types: complete, partial and associated and combined syndromes. The vestibular syndromes are made up of (1) subjective signs, such as sensation of vertigo or pulsion; (2) spontaneous or revealed objective signs (deviations of the head, eyes, trunk and arms or rotation around the axis), and (3) provoked objective signs (revealed by caloric, rotatory and galvanic tests). The complete vestibular syndrome is unilateral or bilateral. When it is bilateral, there may be predominance on one side; nystagmus or a deviation may be so accentuated on one side as more or less to mask the same element of the syndrome on the opposite side. In such a case, only instrumental tests will determine the respective value of one or the other side. Partial vestibular syndromes have been represented until recently by the partial vestibulo-ocular syndrome or the vestibulospinal syndrome. Of the partial vestibular syndromes an important example is crossed vestibular dysreflexia or areflexia, in which the causal lesion is in a restricted segment of the central vestibular pathways, a part of the chiasm of the vestibular pathways.

With a large number of lesions involving the peripheral and bulbomesencephalic segments of the vestibular tracts one observes besides the spontaneous or provoked reactional movements a modification of the general bodily equilibrium. With lesions situated in the temporal, parietal and frontal poles, disturbance of the axial equilibrium of the body is accentuated. Barré believes that the peripheromesencephalic vestibular apparatus is integrated into the general apparatus of equilibration and constitutes a reflex mechanism, the sensorial and motor pathways of which are articulated in the bulb and peduncle. Above it lies an apparatus

for automatic regulation, reduced to a small number of pathways that are assembled in the red nucleus and perhaps a little higher. The hemispheric cortex probably plays an important role in the perception of the sensations of equilibrium or disequilibrium; it is the conscious and voluntary mechanism, disturbance of which is so often shown by retrolateropulsions or other deviations of the axis of the body or even by falling. Ascending pathways from the otoliths, canals and posterior columns and perhaps other pathways are dissociated and distributed to various cortical areas on arriving at the subthalamie or retrolthalamie region. That association pathways from these areas connect with the frontal or prefrontal cortex is probable. It is not astonishing that when the prefrontal area is affected directly or indirectly it may be the point of passage or departure of a disturbance in general equilibration. A special disturbance of equilibration will be created when the representation of space is altered; a different disturbance will occur when the faculty of attention is diminished.

A comparison of the clinical data with the anatomic arrangement is relatively easily made in cases of lesions of the vestibular nerve. This is more difficult with lesions of the bulb. The studies of Lorente de N6 indicate a greater complexity of the intrabulbar reflex pathways than had previously been supposed. Clinical observations indicate a precise anatomic localization for the lesion causing crossed dysreflexia, in one half of the pons, near the midline and slightly above the nucleus of the sixth nerve. This has as yet no demonstrable anatomicoclinical support. In the peduncular region superposition of the clinical and the anatomic descriptions is again easy. The schema of van Gehuchten and Winkler permits a clear understanding of the various particulars of the vestibular syndromes of lesions of the peduncular tegmen, whether they are situated below, at or a little above the red nucleus. Lesions of the hypothalamic cross roads produce diverse disturbances, but the number of cases of vestibular syndromes known to be referable to this region is not sufficient to determine whether the relation is explicable by its anatomic structure. In the regions located still higher the vestibular pathways have scarcely been mapped.

Dusser de Barenne and de Kleyn have shown that in rabbits after the ablation of one cerebral hemisphere the two vestibular mechanisms remain equally excitable and that the quick component of nystagmus, which is toward the side of operation, may be much stronger than that on the other side, whatever the method used to provoke it. The same phenomenon has been observed in man, either as simple predominance of the direction of nystagmus or in a pure and complete state. It is interesting that a minimal or even fugacious lesion in man can produce the same syndrome as ablation of an entire hemisphere in the rabbit. Muskens' experiments on animals led him to postulate "supravestibular pathways," which arrive at the pallidum via the posterior commissure. Serious doubts have been expressed about Muskens' interpretations, but he demonstrated that various *mouvements de manège* and axial rotation can be produced by operation on the highest part of the peduncles. The tendency to axial rotation observed in man in certain cases, associated with a homolateral or contralateral pulsion of the body, generally without nystagmus and deviation of the arms, is a new and important fact and directs attention to the anterior peduncular region. The experiments of Foerster, Spiegel, de Kleyn and Versteegh and Benjamin have yielded interesting data on the physiologic reactions of the region surrounding the interparietal sulcus. This is the only point at which excitation can produce the sensation of vertigo in man. It is probable that the mechanisms of the quick component of nystagmus and of the optokinetic reflex are in connection with this sulcus; it is also probable that fibers from the utricular otolith end there, while those from the saccular otolith go to the auditory center in the temporal lobe. Parietal lesions occupy the first rank among corticosubcortical lesions that may disturb general equilibration.

DENNIS, San Diego, Calif. [ARCH. NEUROL. & PSYCHIAT.]

INTRODUCTION TO THE STUDY OF VESTIBULAR DISHARMONY. I. ALFANDARY, Rev. d'oto-neuro-opt. **16:577** (Nov.) 1938.

The vestibular apparatus occupies an important place in the semeiology of the nervous system. Examination of it is indispensable for the topographic diagnosis of lesions of the cerebral trunk, and the discovery by Barré of vestibular disharmony renders possible the diagnosis of cerebellar lesions, even in the absence of classic cerebellar symptoms. In a harmonious vestibular syndrome all reactions are directed toward the side of the labyrinth excited. However, in certain diseases of the cerebellum or of the brain stem the nystagmus (quick phase) is directed toward the side of the lesion. This phenomenon has been attributed to compression or inflammatory infiltration of the vestibular centers. These hypotheses are supported by experiments and clinical observations, which show that a low bulbar lesion produces homolateral nystagmus, while a lesion at the middle of the bulb causes contralateral nystagmus. Disharmony is a combination of homolateral and contralateral vestibular symptoms, to which is often added the spontaneous, incomplete syndrome: the absence of one of the elements of the vestibular syndrome. In the bulb, the vestibulospinal bundle at a certain level is separated from the vestibular nuclei, and one of them may be affected by a lesion and not the other. In the disharmonious vestibular syndrome the following may be observed: 1. The nystagmus is homolateral; the slow phase is directed toward the side opposite that of the deviation of the trunk and extremities. 2. The deviation of the trunk and extremities is toward the side opposite the irritation. 3. If there is deviation of the head, it is in a direction contrary to that of the other deviations. 4. Deviation during walking is in a direction contrary to the rule. 5. Subjective vertigo is in a direction contrary to the rule.

The author makes the following conclusions: 1. The pure vestibular syndrome is always harmonious, whether the lesion is central or peripheral. 2. The vestibular syndrome becomes disharmonious under the following conditions: (a) Lesions of the cerebellum involving the cerebellovestibular pathway; this path is direct and crossed, and its function is to coordinate reflex movements destined to maintain the equilibrium of the body. (b) Bulbar lesions, either lesion of the vestibulo-oculomotor pathway, which is crossed, or a bilateral lesion of the bulb. In the first instance only the nystagmus is disharmonious; in the second the deviations may also be disharmonious. It is probable that a lesion involving the juxtarestiform body, by disturbance of the same pathways, can produce the same syndrome as a lesion of the cerebellum. (c) Peduncular lesions, in which the disharmonious syndrome has not yet been satisfactorily explained. 3. The disharmonious syndrome always indicates a central lesion of the posterior fossa; most often, it indicates a cerebellar lesion. It must be considered a cerebellar symptom of the same value as other cerebellar symptoms of the series of Babinski and André-Thomas, with the reservations already indicated with regard to bulbar lesions.

DENNIS, San Diego, Calif. [ARCH. NEUROL. & PSYCHIAT.]

RESONANCE OF THE SKULL IN RELATION TO THE STATE OF THE LABYRINTH. T. DEMETRIADES, Rev. d'oto-neuro-opt. **16:608** (Nov.) 1938.

While examining patients with intracranial tumors, Demetriades noticed that in the majority increased cranial resonance coincided with the side of the tumor and of the most marked labyrinthine lesion. Experiments demonstrated that the blood vessels of the cranium play an important role in cranial resonance, the latter being increased on the more hyperemic side. The resonance was measured by placing a band to which were attached two auscultation tubes, around the forehead and the two mastoid regions, setting a vibrating tuning fork on the forehead and comparing the resonance of the two sides of the head through the auscultation tubes. The resonance of the right side is normally greater than that of the left, supposedly because of the greater tonus of the right labyrinth. Other experiments



showed that the labyrinth (vestibular nerve) influences the vascular equilibrium, and hence the resonance, of the head. Stimulation of the labyrinth causes contraction of the vessels and reduction of the resonance of the side to which the nystagmus is directed. On the other hand, a lesion of a labyrinth causes a decrease in the resonance on the corresponding side of the head. Hence, the strongest resonance is found on the side of the most irritable labyrinth, the brain and the rest of the head being normal. If, now, sufficient encephalic hyperemia is produced to overcome the anemia caused by the labyrinthine lesion, the following syndrome appears: increased resonance on the side of the more feeble labyrinth. Examination in 27 cases of cerebral tumor revealed that the syndrome was present in 22. It is important to use Kobrak's caloric method, modified by Demetriades, in order to discover the finer shades of labyrinthine excitability. The phenomenon occurred in all cases of extensive hyperemia of the head, provided the latter or its cause produced a labyrinthine lesion. Such hyperemia accompanies cerebral tumors especially. Disease of the accessory nasal sinuses, malignant tumor of the epipharynx, otitis media and acute mastoiditis may influence cranial resonance.

DENNIS, San Diego, Calif. [ARCH. NEUROL. & PSYCHIAT.]

# Society Transactions

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## AMERICAN OTOLOGICAL SOCIETY

ISIDORE FRIESNER, M.D., *President, Presiding*

ABSTRACTED BY DR. ALFRED LEWY, CHICAGO

*Seventy-Second Annual Meeting, Rye, N. Y., May 22-23, 1939*

OTOLOGIC ADSPICE: PRESIDENT'S ADDRESS. DR. ISIDORE FRIESNER, New York.

The title is taken from the seal of the College of the City of New York, which presents a woman's head looking backward, "Respice"; outward, "Adspice," and forward, "Prospice." If one bases one's judgment soundly on the past and looks honestly at the present, one can view the future with hope and equanimity.

In every field a review of accomplishment, an evaluation of facts and a basis for their application are essential. In business this is called taking stock or inventory, perhaps to calculate pecuniary profit. In medicine the object is to prevent, ameliorate or cure the ills of others. This alone argues that medicine is not a business.

In discussing recent accomplishments in their field, otologists must include related ones in the general field of medicine and science.

Knowledge of the minute anatomy of the temporal bone has become more widespread, but it is still not known how one hears. The Wever and Bray phenomenon indicates that sound causes changes in the electrical potentials of the cochlea. Others show that these may arise from the membranes rather than the organ of Corti.

The Ménière syndrome due to a variety of causes basically seems to be linked to the metabolism of salt and water. On the other hand, if it is always due to interlabyrinthine changes why is the nerve section not always successful?

The advocacy of new remedies is followed too often by indiscriminate application by enthusiasts. The successes are reported; later the unfavorable effects gradually become known. The emphasis of the published reports is laid, to paraphrase Carlisle, on "what the eye desires to see." Otologists are paying more attention to conservation of hearing. This is based on changes in their estimate of values. Formerly the advancement of a student was based almost entirely on scholastic achievements. Today more stress is laid on his ability to adjust to his environment—on his ability to meet life. Any handicap may cause a feeling of inferiority. Otologists are concerned with defects of hearing and disfigurements due to operative procedures. Restoration of a damaged facial nerve is in line with these efforts.

There is an effort for more conservative management of sinus thrombosis. Some are preferring the more horizontal incision in the neck for cosmetic reasons. Increasing experience has demonstrated that surgical intervention on the jugular vein is not invariably necessary in such cases. Sulfanilamide and its derivatives have helped in controlling bacteremia but have little or no effect on avascular tissues, so that the infected thrombus must still be dealt with surgically. There is a departure from the laissez aller attitude toward progressive deafness. The relation between loss of hearing and nutritional disturbances, especially vitamin deficiencies, is being studied; radiation treatment of adventitious lymphoid tissue,

especially about the eustachian tube, is used. But the greatest interest has been aroused by the surgical approach to restoration of hearing. To evaluate this therapy critically one must know the immediate perils due to technic and also the remote dangers. One must know the degree and duration of improvement and how it compares with that obtained by hearing aids. Until all the facts are known one should neither condemn nor exalt the new procedures.

In dealing with infections of the mastoid greater efforts are being made to conserve hearing. To quote Smith, "We remove the danger and allow as much of the conducting apparatus to remain as is consistent with safety." This applies also to deeper infections of the temporal bone.

Outstanding among the advances is the application of sulfanilamide and its derivatives as a bacteriostat not only against *Streptococcus haemolyticus* beta but against pneumococci in the form of sulfapyridine (2-[paraaminobenzenesulfonamido]-pyridine). I cannot forego special mention of the successful treatment of meningitis by these drugs. Heretofore the isolated recoveries were considered miracles. For this one should be grateful.

I conclude that otologists may look to the future (Prospice) with confidence that their specialty will continue to occupy the honorable and important place which it deserves.

#### MODERN VIEWS REGARDING THE ANATOMY AND PHYSIOLOGY OF THE VESTIBULAR TRACTS. DR. OTTO MARBURG, New York.

(This article is essentially an anatomic description and does not lend itself to abstracting. Some of the high lights are touched on here.—A. L.)

The first question is whether the stimulation of the vestibular apparatus is an acceleration, a push or a static wave. In the lower fishes one has the lateral line system, an open channel, stimulated by the waves of the surrounding water. In higher animals there are added to the intermediate stage of a sacculus and two canals a vestibule and three semicircular canals. The wave stimuli can be produced by turning, change in temperature or electricity and also by a blow or the vibration of the tuning fork. The nerves conduct the impulses, the *nervus sacculoampullaris* and the *nervus utriculoampullaris* comprising what I prefer to name the *nervus labyrinthicus* (vestibularis). I also reclassify the vestibular nuclei as nuclei labyrinthici pars intrafascicularis (ventrocaudalis), nuclei pars supra-fascicularis (triangularis), which he says are really one nucleus, and nuclei labyrinthici pars angularis (Bächterew). These constitute the real nucleus labyrinthicus. These are accompanied by the small, cellular nucleus triangularis proper. There are also direct vestibular fibers which end in the oldest part of the cerebellum, the flocculus, the lingula and the nodulus. There are collaterals to Deiters' nucleus. It is possible that fibers or collaterals also reach the reticular nuclei. Every part of the labyrinth is connected with more than one nucleus. Most of the fibers cross by way of the internal arcuate fibers; those from the angular part cross partly at the posterior commissure. The courses of a number of other tracts are traced in detail to their connections with the nuclei of the muscles of the eye.

The oldest function of the labyrinth is the "skew deviation" (every change of position changes the position of the eye), which exists in the lowest fishes and corresponds to the righting reflex. The clonic, or quick, component of nystagmus indicates the side of the lesion in the pons and medulla. These movements are innervated by the healthy side of the labyrinthine nuclei with their crossed fibers. The slow component is to the healthy side because the tonic innervation is not crossed. (The fibers of the angular nucleus cross in the posterior commissure.) The conclusion is that the quick component depends on the pars fascicularis and its pathways, the slow component on the angular nucleus or the nucleus reticularis ventralis tegmenti pontis and their continuations. It appears, further, that the rotatory and horizontal movements are represented by the nuclei behind the sixth nerve. The upward and downward movements are still under discussion. I believe that the nuclei of the labyrinth and the posterior longitudinal bundle innervate the anterior oculomotor nuclei, perhaps supported by the nuclei for the righting reflexes.

Optokinetic nystagmus and cortical innervation of associated movements of the eyes also are traced. Dizziness I look on as a complicated symptom caused by different disturbances in the vestibular system. Conscious perception of vestibular impressions means only impression of direction. Influence of the vestibular on the vegetative system emanates from the proper triangular nucleus by way of the fasciculus triangulointercalatus into Roller's nucleus, ventrad from the hypoglossal nucleus.

To study the reflexes of the neck on labyrinthine stimulation I used the medulla of a giraffe. The connections to the muscle centers of the neck are three: one in the nucleus of the vagus nerve, one in the substantia reticulosa and one in Roller's nucleus. The descending fibers are (1) descending fibers from the nuclei labyrinthici, (2) fibers from the nucleus interstitialis and (3) fibers from the nucleus ruber, the nucleus reticularis and Deiters' nucleus. All the latter fibers originate from large motor nuclei, influenced, on one hand, by the cerebellum and stem ganglion and, on the other, by the vestibular apparatus. The influence of the cerebellum on the labyrinth is one of degree of movement, tonus and power. From the nucleus interstitialis, the tractus interstiospinalis runs medially in the posterior longitudinal bundle for the righting reflex. The nucleus commissuralis also receives fibers from the vestibular nuclei. From the commissural nucleus the tractus commissurospinalis conveys tonic impulses to the postural muscles.

The conclusion is that in the higher animals there is a finely graded apparatus controlling the ocular muscles and all the muscles of the body. These movements are unconscious, but in higher animals there is a direct connection with the cortex through which they get orientation in space. The disorientation is called dizziness. The vestibular system influences the vegetative system also, chiefly through the vagus nerve.

#### ANATOMY OF THE CRANIAL BLOOD SINUSES, WITH PARTICULAR REFERENCE TO THE LATERAL. DR. BARNES WOODHALL, Durham, N. C.

There are several theories as to why the right lateral sinus carries more blood than the left (60 per cent plus, right predominance; 10 to 15 per cent, left predominance). Several different types of arrangement of venous outflow from the cranial cavity are classified as follows:

1. Common pool types, the classic textbook picture, actually less common than other types. The longitudinal and the straight sinus meet in a more or less common pool, from which the blood continues into the lateral sinuses, which are approximately equal in size.

2. Plexiform type. The longitudinal and straight sinuses may be each divided into two divisions; the lateral sinuses usually are unequal but communicate with each other. There are many variations of this arrangement.

3. Ipsilateral type. The longitudinal sinus runs to one side, usually the right, and the straight sinus to the opposite side. Communication between the lateral sinuses, if present, must be through an additional channel or a foramen. In most cases the lateral sinus receiving the flow from the longitudinal sinus will be the larger.

4. Unilateral type, rare. Both the longitudinal and straight sinuses empty into one lateral sinus, the other being absent or attenuated and carrying blood only from minor vessels.

5. Occipital Type. The occipital sinus is large enough to be of value in carrying blood; there may be a large single or paired occipital sinus, similar to the fetal, with large marginal sinuses, or the longitudinal or the straight sinus or both may empty into a large occipital sinus at the expense of one lateral sinus.

Cases observed in which autopsy was done clinically illustrate these types and their subvariations. In certain cases observed clinically in which recovery

occurred evidence of intracranial pressure, both general and localized, was presented. The Tobey-Ayer test is related to the venous variations, and roentgenography, particularly the anteroposterior view, is valuable to demonstrate the relative size of the lateral sinuses.

#### DISCUSSION

STACY R. GUILD, PH.D., Baltimore: There are certain common variations of the relation of the dome of the jugular bulb to the middle ear.

(The variations were illustrated by slides.)

The distance between the floor of the tympanic cavity and the top of the jugular bulb varies greatly. There may be dehiscences in the floor, sometimes so large that almost all the mucosa of the hypotympanum rests on the bulb. When the dehiscences are small crypts of mucosa may project through and extend between the bone and bulb, with the lumen continuous with the middle ear and larger at the distal end. Infection from these crypts may originate primary thrombosis of the bulb. The last two slides show, respectively, attachment of the inferior margin of the tympanic mucous membrane to the jugular bulb and the defect in the ampulla of the posterior semicircular canal. Neither of these conditions produced attributable clinical symptoms.

#### IMMUNOLOGIC ASPECTS OF BLOOD INVASIONS WITH SPECIAL REFERENCE TO SINUS THROMBOSIS. DR. GREGORY SIIWARTZMAN, New York.

Virulence represents a function of two related variables, one the power to invade the host and the other the power of the host to respond to the invasion. Each of these variables depends on a long series of its own variables.

One is given a bacillus recovered from a patient's urine. A mouse's resistance to the infection does not tell one what the patient's resistance is.

Dr. Goldman and I analyzed 168 consecutive blood cultures for *Streptococcus haemolyticus*.

Two group studies were made:

1. The invaders belonged to the same serologic group, but the portal of entry varied.

2. The portal of entry was the same, but the type of organism was different.

There was a definite relation between the portal of entry and the outcome of the disease.

In presulfanilamide days the mortality rate from pulmonary infections, surgical infections, infections associated with nonbacterial diseases, gynecologic infections and osseous and articular infections with an identical strain varied from 100 per cent from pulmonary infections to 20 per cent from secondary erysipelas complicating an infection, with which the expectation of mortality was not increased.

There was a different strain, infecting mostly children, in early spring or late fall, the infection beginning as a disease of the upper part of the respiratory tract without formation of pus, with local recovery, but uniformly producing osteomyelitis of a long bone. There were few organisms in the blood culture, which cleared rapidly. Operative treatment was a great advantage.

The technic of blood culture is as follows: Twenty-five cubic centimeters of blood is taken, 19 cc. seeded into fluid mediums and 4 to 6 cc. seeded into solid mediums.

The number of original colonies per 5 cc. of blood may be taken as an index of the number of bacteria in the blood stream. (Five cubic centimeters is seeded into each medium.)

According to my experience any organism found in the blood stream after surgical mastoiditis is interpreted as indicating involvement of the lateral sinus.

If solid mediums alone were used, the positive cultures would drop 50 per cent; if only one fluid medium instead of three were used, they would drop two thirds.

This applies only to *Str. haemolyticus*. With *Streptococcus viridans* one may observe a transitory and innocuous invasion.

Why does the streptococcus obtain dominance in the blood stream over other invaders of the middle ear? How does it penetrate the three lines of defense—mucosa, mastoid bone and vessels?

The pathogenic group, classified as A by Mansfield on a basis of specific carbohydrates (B, C, D, E, F, and G are nonpathogenic for man) produces an enzyme-like substance, which is fibrolytic for human fibrin. Some types also can enhance the permeability of human tissues to toxins. The toxic factors precede the actual invaders, cause changes in the venous wall and produce a sterile thrombus preceding invasion by the bacteria themselves. The bacteria which can dissolve the thrombus and prevent organization will be able to invade the blood stream. Any secondary thrombus formation will then be associated with more severe phlebitis. I cannot conceive how ligation is of benefit. My idea is to limit the area of infection by promoting organization and allowing the fibrin to acquire immunity.

Infection by the hematogenous route produces severe damage. The effects of local infections or reinfections are slighter.

THE PREVENTION OF DEAFNESS IN CHILDREN. DR. SAMUEL J. CROWE, Baltimore.

When a child with no evident impairment of hearing for speech and no subjective aural symptoms is found to have retracted tympanic membranes and an abnormal amount of lymphoid tissue around the pharyngeal orifice of the eustachian tubes, the audiometric test will invariably show loss of hearing for tones at the upper end of the scale. At first the mucosa of the middle ear is congested and the loss is only for tones far above the speech range. Later the mucosa becomes myxomatous and the child has difficulty in hearing speech. The retraction, at first limited to the membrana flaccida, extends to the anterior quadrant and then to the entire tympanic membrane. This statement is based on a series of audiometric tests on children of from 7 to 12 years. Lymphoid tissue is more abundant before puberty. Removal of tonsils and adenoids does not remove lymphoid nodules in the wall of the eustachian tube and the pharynx and, in fact, may result in their secondary formation. They are best treated by radiation. The diagnosis can be made only by using the nasopharyngoscope. If the examination cannot be made with the area under local anesthesia, avertin with amylene hydrate should be used. Loss of hearing for high tones alone does not always indicate a lesion of the inner ear, nor does loss of perception by bone conduction for a 512 double vibration fork. Retraction of Shrapnell's membrane is a danger signal. Tonsils and adenoids are removed far too frequently in children. In order to safeguard the hearing it is necessary to make examinations of the drum membrane, the pharyngeal end of the eustachian tube and the acuity of hearing for the higher frequencies once or twice a year till puberty. In addition to irradiation I advise using sulfanilamide during acute infection.

#### DISCUSSION

DR. BURT R. SHURLY, Detroit: In Detroit a test of school children showed deficient hearing in 4.8 per cent. In clinics many operations for adenoids are done by novices; final inspection is not done, and poor results are overlooked. The La Force type of adenotome removes only the tissue in the midline. A resolution was recently introduced at a meeting of the American Medical Association asking the help of members in making a nationwide setup for the assistance of children with defective hearing, and the American Otological Society should encourage that. In Detroit there is a follow-up system, and neglected deficiencies are referred back to the family doctor.

In the hurried clinic the examination may be superficial and many things undiscovered. I believe that the key is early diagnosis in the school system and that problems of nutrition are important. I hope that research workers will explain why the lymphoid tissue develops as it does.

DR. EUGENE R. LEWIS, Los Angeles: The ideal is to prevent rather than cure, but prevention has aspects of intangibility. It takes an unusual spirit to

cast his lot where the more he accomplishes the less it shows. What has been prevented is not susceptible of demonstration.

No matter how much transitory impairment is caused by disease, the possibility of restoration of function must be kept to the fore. Recoverability must be supreme among clinical considerations, and conservation of normal equipment and function must be the goal.

DR. WILLIAM MITHOEFER, Cincinnati: There is no small area in the body as rich in veins and nerves as the lateral wall of the pharynx and the fossa of Rosenmüller. The veins of the eustachian tube communicate with the nasopharynx and the middle ear. Pressure in the nasopharynx causes congestion of the middle ear. Congestion of the membrana tympani often disappears after adenoidectomy or after application of cocaine and epinephrine. It is a circulatory disturbance, and therefore hearing for high tones was depreciated in Dr. Crowe's tests.

This is not only a local but a constitutional disturbance, and one should think of hypothyroidism as a frequent disease of childhood and also of hypoglycemia, vitamin deficiency and allergy.

DR. RAFAEL LORENTE DE NÓ, New York: Can the treatment be done by an otologist, or must it be done by a radiologist?

DR. E. E. CARMODY, Denver: How about the use of radium salt?

DR. HORACE NEWHART, Minneapolis: Will Dr. Crowe please explain the limitations of the ordinary phonograph audiometer in disclosing deficiencies of hearing for higher frequencies?

DR. SAMUEL J. CROWE, Baltimore: The nasopharynx is irradiated with an applicator small enough to pass with ease along the floor of the nose. A radon-containing glass tube is enclosed in a brass tip, which acts as a screen. One end is closed; the inside bore is 1.5 mm.; the total length is about 1.5 cm.; the outside diameter is 2 mm., and the thickness of the wall is 0.5 mm. The applicator will hold 50 mg. of radium sulfate or 1,000 millicuries of radon. A safe dose for lymphoid tissue in the nasopharynx of a child is 1.5 to 1.8 gram minutes on each side for the first treatment; a month later 2 to 2.5 gram minutes on each side may be given if necessary. The dose in gram minutes is calculated by multiplying the number of millicuries in the applicator by the number of minutes the applicator is in the nasopharynx.<sup>1</sup> Thus, if the applicator contains 600 millicuries, the minimum exposure is two and one-half minutes and the maximum four and one-fourth minutes on each side.

One must test with an audiometer giving a pure tone up to 16000 double vibrations. When the speech range is involved the deafness is already advanced. No method of treatment avails if the child is 16 or 18 years of age. The solution of the problem in school children is to detect the loss of hearing long before it can be detected with the phonographic audiometer.

HEAD NOISES AND DEAFNESS: PERIPHERAL AND CENTRAL. DR. EDMUND P. FOWLER, New York.

I shall present a method for differentiating peripheral from central tinnitus and deafness and also a method for detecting and measuring certain effects of subaudible and audible tinnitus.

Sustained tinnitus is variously described by different patients. Measurements of its loudness vary from a few decibels above threshold to 45 decibels or more. Tinnitus should be measured for its loudness, its masking by applied frequencies and its masking effect on applied frequencies. There are two kinds of tinnitus, vibratory and nonvibratory. Vibratory tinnitus is caused by actual vibrations reaching the end organs in the cochlea; it is always peripheral; it may occur in normal ears; it is masked by extraneous sounds because it is set up by actual

1. ED. NOTE.—This gives the dose in millicurie minutes; 1 grain minute equals 1,000 milligram minutes, which is equivalent to 1,000 millicurie minutes.

vibrations reaching the cochlea; when present it may lower the hearing by both air and bone as a masking noise does; the effect on bone conduction is constant and important. Vibratory tinnitus is made up predominantly of lower frequencies.

Nonvibratory tinnitus is caused by other factors, such as biochemical stimulation, and is wholly due to factors operating on the neural mechanism. They may be vasomotor. Chemical changes or variations in pressure along the course of the auditory nerve may change its firing rate. Clinically such changes may be evidenced by the Ménière symptom complex. It is independent of vibrations in the cochlea. It may be peripheral or central. Usually higher-pitched sounds predominate. Common excitements are disturbances of the gastrointestinal tract, of the ear itself, of the nose, of the throat or of the teeth. Smoking and temporomandibular dysfunction are causes. The latter is caused by activation of the nerve elements. (A slide was shown.)

Tinnitus must be studied in relation to the following factors: The excitability level of the nervous system and psyche; the type of the underlying factors; the presence and amount of "recruitment of loudness"; if it is vibratory, the predominance of air or of bone conduction, and the summation and masking effect from and on it of a different frequency band coincidentally present. Central tinnitus is masked with difficulty because the projected pattern differs from a peripheral stimulation. Moreover, masking sounds do not get through; they are stopped by the central lesion. Severe obstructive deafness will prevent extraneous sounds from masking tinnitus by air conduction.

These studies have an important bearing on the etiology, prevention and treatment of the disorders causing deafness.

#### DISCUSSION

DR. RAFAEL LORENTE DE NÓ, New York: In 1931 Professor Alien made the observation that the cut end of a nerve is the source of a continuous stream of impulses similar to physiologic stimulation. This traumatic discharge explains such symptoms as pain. A few years later Dr. Gasser found that the discharge could be controlled by chemical means (calcium) and also by changes of potential, which may be recorded. (A slide was presented showing that a change of  $p_{H_2}$  changes the number of nerve impulses.) If ionization of calcium is present, the discharge is increased enormously by adding citrate solution. The nerve is now cut down to one fiber. (A slide was presented.) A rhythmic series of impulses at a high rate, continuing for hours is shown. The citrate is washed off, and the nerve ceases firing except once for each stimulus, which is normal. If the calcium is removed, the nerve ceases firing, but the ganglion is fired spontaneously. If the calcium is restored, the initial state is restored. If there is a disturbance of the acoustic nerve, the impulse produced by the cochlea is followed by another force, which will be heard as a noise. If the disturbance increases, the nerve will produce impulses in succession, and that will be tinnitus. If the tones are due to the nerve acting spontaneously, they can be modified by impulses from the periphery. If the tinnitus is due, e. g., to chemical irritation it will not be affected by a tone delivered to the ear. The laboratory experiment is a nice model of tinnitus.

R. L. WEGEL, PH.D., New York: It appears that for the first time otologists have a quantitative objective measurement of tinnitus. Dr. Fowler has refrained from detailed generalization on account of paucity of data. A provisional subdivision of the cases of his second class of tinnitus would be desirable. The suggested groups are, first, cases in which the tinnitus or its cause obliterates the character of the perceived sound and, second, those in which the interference is no more than an equal amount of noise to a normal ear, that is, cases, respectively, in which each of these conditions predominates over the other. In the first group distortion occurs only at the lower intensities, between threshold and 40 decibels above it. Distortion is limited to a narrow band, one octave in the cases so far reported. The range is different in different ears (only 2 cases available). As the intensity of the test tone is increased, the point at which the



noise is replaced by a sensation of a pure tone is much sharper than at the threshold. Cases of acute tinnitus seem to fall most characteristically into this group. The outstanding contribution in Dr. Fowler's paper is the outline of a quantitative objective technic of measurement of tinnitus.

DR. MAX A. GOLDSTEIN, St. Louis: In a case of otosclerosis in which the tone frequency of the tinnitus has been definitely obtained, why after further loss of hearing has occurred is there a complete cessation of tinnitus?

DR. EDMUND P. FOWLER, New York: Tinnitus always covers a band of frequencies, and many things can change its character. Sometimes simply taking the patient into the test room does it. I had tinnitus from the explosion of a gun some years ago; in a half-hour it disappeared, but after a few years it reappeared with variations. I thought probably it was caused by sclerotic arteries or something else irritating the neural mechanism. I went into the sound-proof room, and it disappeared. It came back later in the day, and I have been able to measure it and its masking. This has happened to several patients. It takes little sometimes to change or stop tinnitus. I now wish to show a roentgenographic motion picture of a jaw joint in passive and active motion. The jaw swings on a broad fulcrum. The head has a back and forth sliding movement; it is pushed down only when it rides up onto the tubercle in marked extension. The angle and ramus swing in an arc like the movable jaw of a biting instrument and give the illusion that the condyle is moving vertically. It rotates clockwise and counterclockwise about a vertical axis in grinding motions. On the side with loss of molars and one bicuspid there was local discomfort and loss of hearing in the tonal areas of tinnitus that was present. The patient avoided discomfort by biting on the other side and not clamping down hard on the stem of his pipe.

THE PROGRESS OF DEAFNESS IN CLINICAL OTOSCLEROSIS. C. C. BUNCH, PH.D., St. Louis.

(Sixteen slides were shown illustrating hearing tests of a series of patients with a diagnosis of otosclerosis lasting over six years.)

The diagnoses in this series were made by trained otologists on the basis of findings with tuning forks, supplemented by audiometric tests which I performed. In no case was the diagnosis based on the audiometric test alone. The progress of the disease varies. It may be rapid, slow, intermittent or stationary or even improve over a long period. The best method of obtaining commensurate values is by the audiometer. The results of hearing tests following operation for otosclerosis recorded only for whisper and voice, unless the distances are great, are not reliable. Sleep, nervousness, fatigue and psychic factors, all play a part. If the patient "wills" to hear, the distance becomes greater. If he is tired, the effort becomes too great, and he quits trying to hear.

Some of the graphs show improvement for some frequencies, loss for others and repeated crisscrossing of the results of various tests at different times. In this study changes greater than plus or minus 5 to 7.5 decibels are considered greater than may be explained by the factor of attention, and a 10 decibel error is allowed for the observational factor. A nurse, told to study lip reading, has improved and continues her duties, and her loss of hearing is not noticed by outsiders. Six women who bore children show no loss. Two who underwent major operations show improvement.

Six years is too small a part of a lifetime to enable one to draw conclusions. It seems certain that time alone is not the factor determining the progress of the disease. With those in whom deafness increased no obvious factor in health or in the tests gave clues on which predictions could be based. Changes in either direction were often unilateral. The patients' own statements as to gain or loss were often not substantiated by the tests.

## DISCUSSION

DR. EDMUND P. FOWLER, New York: I agree with Dr. Bunch. I have observed many patients over fourteen or fifteen years, with a condition diagnosed as otosclerosis, in whom there has apparently been no more change than in the average person not having this disease. Hearing fluctuates up and down but varies little from year to year. When obstructive deafness affects sounds of 40 or 50 decibels advancing nerve deafness may develop with it. There are many interrelating factors to consider, but one should not harbor a defeatist attitude toward one's patients. In many instances the otologist who foretells progressive and severe deafness is wrong.

THE USE AND EFFECTIVENESS OF HEARING AIDS. DR. GORDON BERRY, Worcester, Mass.

I shall take up the subject from the standpoints of the physicist, the otologists and the patient. (In the two latter capacities Dr. Berry is personally qualified and in the first more so than many otologists. A. L.) There is considerable variation of intensity between different parts of speech and between accented and unaccented syllables. The masking effect of extraneous noises must also be considered. The more severe the deafness the narrower the band between the threshold of hearing and painful noise. Normal speech ranges between 90 and 8000 cycles, but the most important frequencies are between 500 and 2000 cycles. The telephone is limited to 300 to 2500 cycles. Two types of portable hearing aid are now available. The carbon granule type has the advantage of lightness and smaller cost of upkeep; it has been longer in the market and is better standardized. It is usually adequate for a 20 to 60 decibel loss of hearing. But its magnification is limited to the frequencies between 300 and 3000 cycles, with a sudden peak at which noises are too loud when others are not loud enough; also it overemphasizes background noises. The vacuum tube type permits more even magnification for all speech frequencies, with less distortion, is more powerful and permits more selective amplification for different types of deafness. Generally it is more suitable for patients with more than a 50 decibel loss of hearing and for those with inner ear deafness. The bone conduction type may be preferred for conduction deafness; the air conduction, for nerve deafness. The bone conduction instrument requires more amplification but is less likely to cause pain when high intensities are used—for some find it necessary in order to hear the faint consonants to set the rheostat so high that loud sounds are almost painful. The ear piece is usually preferred by men and by those who use a box instrument. It can be slipped in and out more easily, while the spring headband is more easily concealed by women. It is best to have the fitted earpiece, when this is used, of hard material, both for hearing and for comfort. Wet batteries which can be recharged may be used when it is desired to maintain a high voltage but are larger and of greater initial cost. Stationary sets can be made to plug in on street current. A high grade battery concern should make batteries to fit all types of connection and overcome the individual monopoly each company tries to institute by unique connections. More than one company is offering to deal directly with the physician, and another offers considerable reduction if the profit to the middle man can be so saved. According to my own experience there is a process of adjustment in the use of a hearing aid—the sounds at first seem strange; so a conscientious trial is necessary.

Most patients need an aid long before they will accept one. The otologist should not make an issue of it but should have the patient try one "for occasional use." A trial before purchase helps. At this stage it is the speaker's "poor diction" or the "poor acoustics of the hall," not the patient's deafness, that is at fault. A visit to the League for the Hard of Hearing to see members using aids without embarrassment helps. Increasing deafness makes the patient's earning ability precarious. I believe that wearing a hearing aid is not a barrier to business contacts.

On the contrary, mishearing and an erroneous reply create the idea of stupidity or deafness and strain the relation. The ear phone makes him more efficient and honest with his environment. When the deafness is so severe that an electric aid is inadequate the hearing tube should be used, and the patient is fortunate indeed who has learned lip reading early, before this severe stage has been reached.

A hearing aid does no harm. On the contrary the effort to use it keeps the acoustic function keener, but one must avoid amplification to the point of painful sensation. Before the final purchase the hearing with the aid should be checked by the otologist, and it should have been tried out first in the patient's normal environment. After considering the audiometer test, the graduated vocal test under calibrated control and tests under a normal environment, I prefer for practical purposes sentence tests with the spoken voice under a normal environment. The hearing aid should increase the distance at which sounds can be heard about five times at least.

In conclusion I wish to stress the acoustic gain and personal comfort that accrue from a properly fitted hearing aid, and I believe that the otologist is in a strategic position to guide the patient and relieve him of worry. The making of hearing aids is becoming an exact science, and I bespeak the support and encouragement of the members of the American Otological Society.

#### DISCUSSION

HARVEY FLETCHER, PH.D., New York: I believe the carbon set can be made to do as well as the vacuum tube set. It all depends on the kind of carbon microphone and the kind of vacuum tube set in question. My guess is that the future will see more carbon sets, because they are capable of functional improvement and of being made smaller and more convenient.

Bone conduction receivers are less efficient than air conduction receivers by about 40 decibels, so the patient must have that much better hearing by bone to get the same result with the same power. If the loss of hearing is 80 decibels, there is probably nerve deafness, and it is unlikely that the bone conduction will be 40 decibels greater than that by air. The sentence test is the most practical. Twenty sentences are sufficient.

DR. HORACE NEWHART, Minneapolis: It has become an important function of the otologist to help his aurally handicapped patients. The number of persons who can be helped has been increased. The otologist who recommends a given device without investigation risks discrediting himself and the manufacturer. He should recommend the type best suited to the patient, charge a reasonable fee and never accept a commission or bonus in violation of medical ethics. The patient should be allowed a period of trial on the basis of a reasonable rental. This procedure is not favorably regarded by the average salesman, but he should see the wisdom of permitting this privilege. The otologist should cooperate understandingly with the ethical vendor of "accepted" hearing aids. The patient should understand that the hearing aid is not a complete solution of his problem and that effort should be made to conserve his residual hearing by contact with his physician. Patients should also be warned against exploitation by unscrupulous dealers. The possibility of litigation on account of real or alleged unskilful attempts to obtain a cast for the earpiece should be remembered.

DR. KENNETH M. DAY, Pittsburgh: During the past five years I have experienced an increased loss of hearing for high tones, due, I believe, to overuse of my hearing aid. I have only a narrow margin between the threshold and a sensation of pain. This probably occurs only in cases of fixation of the stapes, as there is no buffer against loud jarring noises. I wear a receiver in each ear and with less amplification get an increased intelligibility of 30 per cent. I can better differentiate conflicting sounds, but with both ears plugged I had to reeducate my voice. I hear better by air conduction because of loss of bone conduc-

tion for the higher tones. Distortion of his own voice, by plugging the ear, leads a patient to believe mistakingly that he hears better by bone, besides being more conspicuous.

DR. EDMUND P. FOWLER, New York: Did the hearers notice how clear were the voices of Dr. Berry and Dr. Day? The hearing aid is a great help to the hard of hearing in modulation of the voice.

THE USE OF THE MONOCHORD IN ROUTINE TESTS OF HEARING. DR. FREDERICK T. HILL, Waterville, Me.

Bunch says of all the devices available for determining the upper tone limit he considers the monochord the most satisfactory for both air and bone conduction. It has the same amplitude for both air and bone. The tuning fork stem used for bone conduction has only one-hundredth the amplitude of the prongs. The audiometer does not have its intensity for high tones, and those ordinarily used do not extend above 8192 double vibrations. The monochord is normally heard by bone 2000 double vibrations above the level at which it is heard by air conduction. With advancing age there is a loss for high tones of 1000 to 2000 double vibrations per decade above the third, at which time the normal range is 20,000 (approximately); toxemias and otitis media may cause loss for high tones. That this is not merely mechanical is shown by the fact that the loss by bone is in the same ratio. There are no differences after removal of impacted cerumen or paracentesis; consequently I believe that lesions of the middle ear may also cause degenerative processes in the internal ear, which are made manifest by the monochord. Crowe has shown that loss of hearing for high tones is an early symptom of a pathologic condition of the eustachian tube and occurs with loss of ossicular mobility. It may also be a symptom of acoustic tumor or Ménière's disease. Loss of hearing for high tones by bone conduction is more indicative of nerve deafness than loss of hearing by air. The ear not being tested must be carefully masked. With chronic suppurative otitis media one usually finds loss along the entire range by the audiometer. This may be of good prognostic value if the hearing for high tones is preserved by bone conduction.

#### DISCUSSION

DR. D. HAROLD WALKER, Boston: Any help in measuring the hearing by bone conduction is valuable in obtaining information regarding the condition of the internal ear. The monochord may prove of great value in determining the advisability of fenestration of the semicircular canal if that operation becomes established.

C. C. BUNCH, PH.D., St. Louis: The tone of the monochord is intense and difficult to control for measurement. This handicap must be overcome if one is to use the monochord effectively. The audiometer, the tone of which is measurable, does not give sufficient intensity in the high frequencies. In the sound-proof room the fan may be turned on without any masking of the monochord. When the patient cannot distinguish between the "squeak" and the rubbing one knows one is reaching the high tone limit. With the Galton whistle the hiss is confused with the whistle. With the Koenig rod the thud of the hammer may be difficult for the clinic patient to distinguish from the ring. Two Bárány noise apparatus often fail to mask the squeak of the monochord; nevertheless it is the most valuable of the three instruments.

DR. WERNER MUELLER, Boston: The monochord is musically important as a way station between the bowstring and the grand piano. Scientifically it has no peer as a producer of accurately measurable tones. As an audiometric instrument it has not had the place it deserves. It is simple in construction and manipulation. The length of the vibrating portion of the steel wire is set by a sliding metal block, and the pitch read off by the numbers engraved on the side

of the ruler. It lacks the adventitious noises of the Galton whistle or the König rods. It can be used in testing for bone conduction. If kept free from rust it retains its tone almost indefinitely. If the string breaks it is easily replaced. The size of the string and its tension make little difference. The pitch is determined by the speed with which sound will travel in steel. The original monochord had a range of from 6000 double vibrations up. The Schaefer modification, by using either a bow or a hammer for transverse vibrations brings this as low as 435 double vibrations. (It goes even lower. A. L.)

DR. FREDERICK T. HILL, Waterville, Me.: The patient I mentioned was deaf for high tones in one ear; so masking was not an important factor.

THE ENDAURAL ROUTE. DR. D. E. STAUNTON WISHART, Toronto, Canada.

A triangle of skin is removed from the posterior, external and superior portion of the canal, which is not cartilaginous, the aperture enlarged by a vertical incision in the incisura auris anterior and the periosteum pushed back, and then, by using two hand retractors and pulling on one and relaxing the other according to the part desired uncovered, the entire field can be exposed. Unusual illumination is necessary. Difficulty may be encountered in exposing the retrosinal cells and those of the tip if they are far back. Particularly difficult is this approach if the soft tissues are swollen or scarred. Hemorrhage is another handicap. The assistant who holds the retractors must be skilful and have endurance. The immediate dressing is simple, only pockets, if any, requiring packing for drainage. The after-care makes great demands on the operating surgeon, as the meatal region is sensitive and the dressings cannot be properly done by a nurse or intern. When excessive granulations occur, the healing is especially tedious. The period of hospitalization averaged considerably more than in cases of postauricular incision. The comments of patients, 2 of whom had also had operation by the postaural route, were generally favorable to the intra-aural approach. The vertical incision, if continued into the temporalis muscle, may introduce infection. It must be packed open. (In 1 case in which it was sutured abscess developed.) Occasionally scarring occurs, and, if so, it is conspicuous as compared with a scar hidden by the auricle. The operation should not be undertaken by a surgeon not specially trained for it and even in expert hands requires more time. This approach gives better visualization of the middle ear and is therefore to be preferred for the fenestration operation. However, I prefer the postaural incision for simple mastoidectomy, which does not require visualization of the middle ear, and for most radical mastoidectomies, which require removal of much diseased tissue. The skin flap of the endaural method can be so manipulated as to make a satisfactory graft for the facial ridge and mastoid bowl in the radical operation.

Whiting's rules for the modern mastoidectomy call for "complete eradication of all diseased bone, in the shortest time commensurate with thoroughness, by methods designed to reduce to a minimum dangers incident to the operation and calculated as well to induce speedy and permanent healing." I conclude that the endaural route is not the method of choice for simple or radical mastoidectomy.

#### DISCUSSION

DR. JAMES A. BABBITT, Philadelphia: I am in agreement with the statement of the necessity for great care in incision, the advisability of postauricular incision in operation for acute mastoiditis, the requirement of the personal attention of the operating surgeon to postoperative dressings and the advisability of having any secondary mastoiditis which may arise operated for by one who understands the endaural route. I have not observed that there is danger of introducing infection into the temporal fascia, that the procedure takes longer than operation by the postauricular route or that it has produced secondary perichondritis. If the periosteum is well lowered there is good exposure of the tip and the postsinal regions. Granulations may be due to careless injury to the posterior wall. They are disturbing and

long lasting, and their treatment, rather than the difficulties in procedure, should be emphasized. Besides excluding this approach for simple mastoidectomy, I should favor its use in radical operation in cases in which precise work is required in the middle ear and in fistulization.

DR. D. E. STAUNTON WISHART, Toronto, Canada: I had only 1 case of infection in the temporal region; still, with all respect to Dr. Babbitt, I think I was fortunate. His criticism that I have not sufficiently emphasized the treatment of granulation is correct. It is of great practical importance.

#### RADICAL MASTOIDECTOMY; USE OF THE TENSOR TYMPANI MUSCLE IN CLOSING THE EUSTACHIAN TUBE. HENRY M. GOODYEAR, Cincinnati.

In every simple mastoidectomy drainage from the antrum through the posterior wound should be maintained until the middle ear is healed. Cholesteatoma with a small perforation in the attic in children should be treated with a modified radical operation. Even with a dry ear in such a case intracranial complications may suddenly develop. When the attic is involved I remove the external wall of the attic with a Richards curet until the epitympanic recess is fully exposed and communicates with the antrum. The malleus is visible but is not amputated. The outer matrix of the cholesteatoma and the ear drum are disturbed as little as possible. For a high posterior perforation the dissection is carried forward only to include the perforation. The incus is removed if necessary. A circular skin flap according to the technic of Whiting is used and the cavity packed with iodoform. For the complete radical operation I prefer a burr and a round curet to avoid possible petechial hemorrhages into the labyrinth. The table is tilted 25 degrees for convenience, and the anterior and inferior walls of the canal are curetted to widen the tympanic cavity and give better access to the mouth of the eustachian tube. The tensor tympani muscle is identified by its ligament; the processus cochleariformis is broken down and the muscle tucked into the mouth of the tube as a transplant. The muscle is usually more than large enough. I have used this method for eighteen years. The methods of others may be cited, but I believe that mine succeeds best, as the muscle is left attached to its blood supply as a live graft.

#### DISCUSSION

DR. LEROY A. SCHALL, Boston: Dr. Goodyear's statement that the appearance of the tympanum and not the appearance of the posterior wound should be the guide to the progress of the healing should be drilled into every house officer. There is no mention of the diagnosis of cholesteatoma by roentgen rays. By the usual plates cholesteatoma can be diagnosed in 45 per cent of cases; with the base plate, in an additional 25 or 30 per cent. In 25 per cent of cases it cannot be demonstrated, as there is as yet no erosion of bone. I believe the endaural route will become more popular with better selection of cases. The use of the tensor tympani muscle to close the tube is logical and should be practical. It was formerly thought that many failures to obtain a dry ear were due to a patent tube, but many patients with a dry ear have an open tube. The better selection of cases for tympanal mastoidectomy has been responsible for this. The recurring infection of the tympanic cavity due to a pathologic condition in the nasopharynx is not treated by this type of operation.

#### SULFANILAMIDE AND ROENTGEN RAY THERAPY FOR ACUTE OTITIS MEDIA AND MASTOIDITIS. DR. FLETCHER D. WOODWARD, Charlottesville, Va.

A statistical survey is made for eight years before the use of sulfanilamide and for two years thereafter. The dose was  $\frac{1}{2}$  grain (0.03 Gm.) per pound (0.5 Kg.) of body weight per twenty-four hours. Occasionally the drug was used parenterally. There have been some untoward reactions but no serious complications. Sulfapyridine (2-[paraaminobenzenesulfonamido]-pyridine) was used in few instances. My associates and I feel that surgical indications should not be

influenced by the administration of this drug. There have been some dramatic cures of streptococcic and pneumococcic infections, and there should be no hesitation in rendering to Domagk full credit for his original work. Our good results were with certain types of *Streptococcus* and *Pneumococcus*, which fortunately are responsible for the majority of aural infections. *Staphylococcus*, *Streptococcus viridans*, *Bacillus proteus*, *Bacillus hofmanni*, *Bacillus influenzae*, *Bacillus tuberculosis* and diphtheroids were not influenced. The ratio of mastoidectomy to otitis media was reduced, as were complications except meningitis, of which there were 8 instances with 6 deaths. In all these the condition either was present on admission, was due to organisms not influenced by sulfanilamide, occurred in patients in poor general condition or was of an unusually fulminating type. One recovery was from infection with *Pneumococcus* type III and 1 from petrositis, epidural abscess and sinus thrombosis due to *Streptococcus haemolyticus*.

In 34 cases acute otitis media was treated roentgenologically. We did not feel that such treatment was of any value for this condition. It was of benefit for reduction of lymphoid tissue in the nasopharynx and about the orifice of the eustachian tube, for the control of granulation tissue after radical mastoidectomy and for control of polyps and granulation tissue in chronic purulent otitis media.

#### DISCUSSION

DR. JOHN R. PAGE, New York: It is difficult as yet to evaluate the results of the use of sulfanilamide from the records of the Manhattan Eye and Ear Hospital. In 1934, without sulfanilamide, 938 ears were submitted to myringotomy and 369 to mastoidectomy; i. e., 39 per cent required operation. In 1937, with the use of sulfanilamide, there were 1,029 ears submitted to myringotomy and 389 to simple mastoidectomy, or 38 per cent operated on. These results are not far apart. The mastoidectomy record is so high for both years that I think the attacks must have been unusually severe, for in my own service among 836 myringotomies in another year without sulfanilamide there were 43 mastoidectomies with 1 death, 5.1 per cent. This is as good a record as that of Horan and French, cited by Dr. Woodward. For meningitis cures have been effected that would not have been obtained without it. Sulfanilamide has confused otologists' interpretation of mild involvement of the mastoid, as it has roentgenologists'. Apparently the drug is not as efficacious in the bone as elsewhere, and one must be careful not to be deceived. It happens more frequently now that the tympanum apparently clears up and the infection in the mastoid continues to smolder. The drug is tricky, and I do not use it for ambulatory patients. I wish to report on a patient who had mastoidectomy in childhood but experienced continued discharge. He was treated by roentgen rays thirty years after, but he had daily rise of temperature, headache, loss of weight, odorless discharge and no evidence of cholesteatoma. On reoperation a completely reformed cortex was encountered; the antrum was dry and lined with atrophic membrane; the attic was open and free; the cancellous portion was bloodless; one softened area extended deep into the petrous bone. In the lower part of the mastoid several large cells were filled with pus, and the contiguous sinistral wall looked infected. Apparently absorption was from there. Prompt recovery occurred. The events in this case seem to show that roentgen rays had an effect on granulation and on the mucoperiosteum of the mastoid cells but did not stop the infection in the lower part of the mastoid. They probably promote drainage by this selective action on granulations and swollen mucosa, but are contraindicated for advanced involvement of the mastoid. Until the roentgen therapists learn more about clinical otology and the otologists more about roentgen therapy, I shall continue to take my chance with a good clinical otologist.

STUDIES OF THE WALTZING GUINEA PIG. DR. MOSES H. LURIE, Boston.

The waltzing guinea pig tends to run in circles either to the right or to the left. It has a fine tremor of the head and is deaf. These characteristics are inherited and follow the mendelian law for a recessive characteristic. The righting

reflexes are normal. The eyes do not respond to vestibular stimulation. The eyeball is normal histologically. The vestibular portion of the labyrinth is histologically normal. The saccule does not degenerate with the cochlea. No evidence was obtained that the saccule had anything to do with the reception of sound. These observations indicate that the lesion is a central nervous one, and it is believed to be in the region of the red nucleus. The principal abnormal histologic observation is progressive degeneration of the organ of Corti, beginning at the first and second turns and progressing toward the helicotrema. Studies of intrauterine and newborn animals showed that the lesions were not due to congenital lack of development but were degenerative. The changes were less marked in the cochlear nerve and the spiral ganglion. Experimental cutting has shown that the cochlear nerve can degenerate without degeneration of the organ of Corti. The animal develops a normal end organ which later degenerates. This is attributed to a hereditary factor, and perhaps human deafness can also be due to a hereditary degenerative factor not necessarily otosclerosis.

EXPERIMENTALLY INDUCED CIRCLING (WALTZING) IN THE GUINEA PIG. DR. MOSES H. LURIE, Boston, and DR. E. W. DEMPSEY, Boston.

Cutting the eighth nerve or destruction of one labyrinth in the guinea pig did not produce the characteristic phenomena of waltzing.

The animals did not show nystagmus on circling or movement of the head.

Enucleation of the eyeballs of the waltzing guinea pigs did not stop the waltzing. The eyes were histologically normal.

Righting reflexes were normal.

The vestibular labyrinth was histologically normal.

The vestibular nerve and its medullar endings were normal. In experimental operations it was found that to produce circling the lesion must be placed just caudal to the mamillary bodies. The operative mortality was exceedingly high, hemorrhage being the chief cause. All the animals that recover after anesthesia move in circles. If the lesion is in the left side of the brain, circling is to the right (clockwise). The animals can go in a straight line. After some days there is beginning compensation. Two animals that survived now show dilatation of the left pupil, fixation of the left eyeball, a tendency to turn to the right and tilting of the head to the right. The third survivor showed only the circling. We believe that the cause of the circling is a break in the reflex between the vestibular apparatus, the nucleus of the third nerve and the postural centers. A lesion in the region of the interpeduncular nuclei may cause symptoms similar to those seen in the waltzing guinea pig.

#### DISCUSSION

STACY R. GUILD, PH.D., Baltimore: I object to the term "waltzing." The behavior is similar to that of other animals and birds which can walk straight and eat normally at times and at other times undergo forced movements. I do not question that the lesion in the experiments is in the interpeduncular nucleus, but it involves other structures. Can it be that the neck reflexes are the cause? One can fasten a pigeon's head back and get peculiar forced movements. I agree that there is cochlear degeneration rather than malformation, but there is concomitant degeneration in the cells of the external sulcus in areas in which the end organ is atrophied. In man this seems to precede degeneration in the organ of Corti. Dr. Crowe, Dr. Polvogt and I described this in the "Pathology of High Tone Deafness." I do not know the relation. I doubt if this investigation gives any clues as to Ménière's symptom complex. I do not think Dr. Lurie meant to imply that every one believes that the only form of hereditary deafness is otosclerosis. There is a rich literature describing other forms of hereditary deafness.

DR. WILLIAM J. McNALLY, Montreal, Canada: Dr. Lurie mentioned shaker guinea pigs. It is possible to produce shaker frogs by removing the semicircular canals and leaving the utricles intact. The animals are greatly disturbed, and their



heads keep bobbing up and down uncontrollably. One of the difficulties in interpreting labyrinthine reactions is that the distribution within the brain stem of the nerves from the different end organs is not known. It is possible that Dr. Lurie's animals have a lesion of the brain stem, possibly involving canals with intact utricles, and it may be that if he and Dr. Dempsey can localize that lesion they will be among the first to tell something about the distribution in the brain stem of the nerves from the end organs of the canals, on the one hand, and the vestibule, on the other.

DR. MOSES H. LURIE, Boston: I am sorry Dr. Lorente de Nó could not be present. "Waltzing" is the term used in genetics to describe this animal. It acts like the so-called waltzing mice. The question of neck reflexes is interesting, because Professor Ibsen has written me that he has found a shaker guinea pig. The head of a shaker mouse goes up and down when he is excited, and there is a tendency to fall backward. Dr. Dempsey has removed structures anterior to the lesion; he has removed the whole of the mamillary bodies, and it is only when the lesion is caudal to the mamillary bodies and in the interpeduncular nucleus that the circling syndrome occurs. In animals which survived removal of half the midbrain there was no circling. I think it is important to get rid of the misconception held by some that any progressive deafness with a hereditary history is otosclerosis, especially in children, who may be totally deaf in one ear when one cannot find a reason for it. I wish to thank Dr. Guild for raising important points on interpretation of facts, for, after all, he did not read the paper. One of the great difficulties in working with animals with inherited tendencies is that one observes no gross lesions. In the brains of waltzing guinea pigs, using different types of nerve stains, Dr. Dempsey and I were unable to distinguish the regions of the vestibular nuclei from those of normal animals.

#### SKULL FRACTURES INVOLVING THE EAR. DR. W. E. GROVE, Milwaukee.

Two hundred and eleven cases of fracture of the skull among 1,187 cases of injury to the head were studied in detail after hospitalization. Also a group of 152 cases of injury to the head including 17 cases of fracture of the skull were studied within twenty-four hours of admission to the hospital. Of the latter group damage to the ear appeared in 49.

In the group of 211 there were 146 cases of longitudinal and 16 of transverse fracture of the temporal bone and 49 of fracture of the vault or miscellaneous fractures. Briefly, longitudinal fracture is a lesion of the middle fossa through the tegmina antri and tympani and the middle ear and sometimes through the canal. It is frequently associated with bleeding from the ear, and if the dura is torn, with leakage of cerebrospinal fluid. Bleeding has been known to occur late, even four weeks after injury. Transverse fracture is a lesion of the posterior fossa, crossing the pyramid and involving the labyrinthine capsule and its contents and often the facial nerve. There is loss of function and spontaneous nystagmus. It may be combined with longitudinal fracture, and then bleeding from the ear occurs. Fractures may be microscopic and not demonstrable except by histologic methods. It is possible to have a transverse fracture without total destruction of function. It is possible also to have injury to the head with destruction of the function of the inner ear without fracture. Because much of the labyrinthine capsule is formed of enchondral bone, healing largely takes place by fibrous union instead of bony, and there is always danger of late meningitis, even years later, if otitis media occurs in a case in which there is also a communication with the middle ear. In addition to the symptoms mentioned, hemotympanum, hydrotympanum, ecchymosis in the area of the mastoid several days after injury and radiologic evidence of fracture may be found. For visualization of transverse fracture the Stenvers position is best, and the roentgenogram need not be taken early. For longitudinal fracture the picture should be made as soon after injury as possible. Even with several exposures many such fractures will be missed.

Paralysis of the facial nerve occurred with 31 per cent of transverse and 18 per cent of longitudinal fractures. It was permanent with 1 transverse and 5 longitudinal fractures. In the remainder it improved or cleared up entirely. Immediate paralysis is due to a lesion of the nerve. Late paralysis is due to hemorrhage into the canal and secondary neuritis. Cure is the rule but may take several months.

Cochlear function cannot be determined immediately because of cloudiness of the sensorium. Later, as many such cases are medicolegal, one must be on guard for malingering and bear in mind that one does not have knowledge of the previous state of the hearing. With longitudinal fracture the damage was greater in general in older people. Some showed no loss of hearing, but many showed a perceptive type of deafness and in many cases equal loss in both ears. This indicates that *commotio labyrinthi* exists, if one understands by this hemorrhage into the inner ear. In all my 16 cases of transverse fracture there was total loss of hearing on the affected side. On the contralateral side 3 patients had normal hearing, and 3 had slight and 7 moderate to subtotal loss. Fractures which do not directly involve the temporal bone may affect the hearing, and this occurs almost in direct relation to the age of the patient. With longitudinal fracture there is usually a combined type instead of a pure conduction type of deafness. In approximately 75 per cent of all cases of fracture of the skull vertigo was complained of, and the irritation was diagnosed as central in origin.

The mortality from basal fractures of the skull averages 55 per cent. Eighty-five per cent of the deaths occur in the first forty-eight hours. About 15 per cent occur later, usually of meningitis, and this may occur after apparent convalescence; death even sixteen years after a transverse fracture is reported. Nine of my patients who discharged cerebrospinal fluid recovered, which controverts the black outlook given this symptom by Davis. As to management of the condition in the ear, I recommend noninterference, the ear being protected with sterile cotton or gauze. If suppuration is present or supervenes with longitudinal fracture the usual surgical indications for mastoidectomy are awaited. With transverse fracture suppuration calls for immediate intervention with exposure of the dura and with drainage of the labyrinth if there is any evidence of meningitis.

#### DISCUSSION

DR. ALFRED LEWY, Chicago: The subject of Dr. Grove's monograph is important from the standpoint both of the immediate management of the condition and of the medicolegal aspect of the sequelae. The subject is inadequately handled in the literature. In particular, discussion of the precise indications for and technic of surgical intervention is lacking or is controversial. The frequency of otologic complications with fracture of the skull shows the importance of otologic consultation in cases of severe injury to the head.

I suggest a clinical classification of such injuries, as follows:

1. Injuries to the head involving the middle and the external ear.
2. Injuries to the head involving the internal ear and the vestibular system,  
(a) with escape of cerebrospinal fluid, (b) without escape of cerebrospinal fluid,  
(c) with otitis media present at time of injury and (d) with otitis media developing after injury.

Patients with injuries involving only the middle or the external ear are operated on only for uncontrollable hemorrhage (which is rare) or for otitis media on the usual indications for mastoidectomy. Those with injuries involving the internal ear are operated on immediately after shock is overcome if purulent otitis media is present or on its advent. If there has been escape of cerebrospinal fluid the tear in the dura should be uncovered and a Neumann labyrinthectomy performed. If meningitis is present the internal auditory meatus should be included, the cisterna pontis lateralis thus being drained. If no escape of cerebrospinal fluid and no open communication exists with the internal ear a Hinsberg operation

may be added to the radical mastoidectomy. New developments in chemotherapy may modify the present recommendations. If definite evidence of communicating fracture is lacking a more conservative course may be justified.

If routine exposures plus a basal plate do not disclose a suspected fracture, the Stenvers position for transverse and the Mayer position for longitudinal fractures are recommended.

#### A SURVEY OF THE USE OF SULFANILAMIDE FOR ACUTE OTITIS MEDIA. DR. KARL M. HOUSER, Philadelphia.

Questionnaires were sent to each member of the American Otological Society, to two hundred and fifty-five other otologists in the United States and Canada and to one hundred and fifty pediatricians. One hundred and eighty-four answers were returned, representing thirty-seven states and Canada. Of those replying 89.6 per cent use sulfanilamide for otitis media; of these 60 per cent believe it should be used early, 58.5 per cent not even awaiting identification of the infecting organism. The total number of cases reported was 9,667. The mortality was 0.041 per cent. Seventy-six per cent of those replying believe that the incidence of acute mastoiditis was reduced. Only 46 have had experience with control cases and none with a sufficient number to permit drawing reliable conclusions. Twenty-seven per cent used the drug for the nasopharyngitis preceding otitis media. Corr and Root stated that the smallest amount of sulfanilamide reported to have been administered before the onset of granulocytopenia was 25 Gm. and concluded that a total distributed dose of 20 Gm. is safe. The average administration was  $\frac{3}{4}$  to 1 grain (0.05 to 0.06 Gm.) per pound (0.5 Kg.) of body weight the first twenty-four hours, decreased as the condition permitted. Frequent examinations of the blood should be made. The fact must be recognized that sulfanilamide will not cure an infected mastoid that has undergone necrotic change. According to Lockwood, the efficiency of this drug depends on the ability of the blood stream to distribute blood to the infected parts, which it cannot do to necrotic areas. In the University of Pennsylvania Hospital the incidence of surgical mastoiditis has not changed in three years, but there the patients when admitted are usually suffering from advanced conditions.

Ninety per cent of the physicians reporting are using sulfanilamide. Perhaps mostly the enthusiasts replied.

Sixty per cent believe that it reduces the incidence of acute mastoiditis, and the majority believe that it should be used early.

If a pneumococcus is found or its presence suspected, the preference should be sulfapyridine.

The concentration in the blood is probably not important.

The survey shows that the use of sulfanilamide for otitis media is widespread and that the users are enthusiastic. This enthusiasm lacks the support of control cases.

#### DISCUSSION

DR. HARRY P. SCHENCK, Philadelphia: The value of the drug against most beta hemolytic infections has been established, but its use for otitis media remains controversial. Dr. Houser's figures indicate which way the wind is blowing. The survey brings out the lack of control and of bacteriologic studies. If it were only possible to determine the organisms in the cases in which the drug appears ineffective, statistics would acquire more significance. For pneumococcic infections both sulfanilamide and serum should be used, because the drug is only bacteriostatic, while the serum neutralizes the toxins. Satisfactory results cannot be expected when the influenza bacillus or Staphylococcus is the infectious agent. Sulfanilamide does not eliminate the necessity for paracentesis or surgical drainage, regardless of the location of the abscess. Three peculiarities of the drug deserve reemphasis: Fever due to the drug may make differential diagnosis difficult; withdrawal may be followed by exacerbation not controlled

by readministration of the drug; an atypical clinical course may result in bizarre surgical and roentgenologic findings. The effect of sulfapyridine (2-[paraaminobenzenesulfonamido]-pyridine) against pneumococcic and other infections deserves further study.

DR. HENRY M. GOODYEAR, Cincinnati: Sulfanilamide sometimes causes leukocytosis. In 1 case a leukocyte count of 85,000, with 92 per cent lymphocytes, and in another a count of 80,000, returned to more normal proportions after discontinuance of its administration. If sulfanilamide in sufficient doses does not bring results in three or four days, there is no use in continuing to administer it. It may be dangerous.

DR. RALPH A. FENTON, Portland, Ore.: It was important to find out what the pediatricians are doing. Under sulfanilamide therapy the symptoms may subside; the child apparently gets well, but three or four weeks later violent complications appear. My associates and I have observed such cases, and it usually turned out that the pediatrician had relied entirely on the drug. When used, the drug should also be administered regularly through the night to keep up the concentration in the blood.

DR. ALFRED LEWY, Chicago: The general statement that sulfanilamide is not useful against pneumococcic infections is incorrect. There are a number of cases of pneumonia due to infection with *Pneumococcus* type III, and I know of 1 case of meningitis of this type in which the patient recovered under sulfanilamide therapy. It may be necessary to differentiate cases for chemotherapy a little more closely.

DR. FREDERICK M. LAW, New York: It has been proved that the drug has no effect on absorption of bone. It masks the symptoms, and a single film is insufficient. The absorption occurs in the deeper cells, and with a single film one may visualize only the cells immediately beneath the cortex. One should have a stereographic pair, preferably at different angles. These cannot be projected on the screen; so I advise the otologist to go to the roentgen room and familiarize himself with stereoscopic technic and interpretation.

DR. FREDERICK T. HILL, Waterville, Me.: If sulfanilamide is bacteriostatic rather than bactericidal it will lower the virulence of the organism, with consequent lowering of the resistance of the patient. One must keep in mind possible sequelae due to lowered resistance.

DR. KARL M. HOUSER, Philadelphia: It was not my intention to leave the impression that sulfanilamide is not efficient against pneumococcic infections, but in a well controlled series of cases my associates and I found sulfapyridine superior against pneumococcic infections, and we give it the preference when we know this is the infective agent.

#### REPORT OF UNUSUAL BACTERIAL FINDINGS IN A CASE OF FATAL CHRONIC OTITIS MEDIA WITH COMPLICATIONS. DR. HORACE NEWHART, Minneapolis.

The isolation of a rarely encountered anaerobic, gram-negative, non-spore-forming micro-organism of the genus *Bacteroides*, from the blood of a patient dying of otogenous sepsis, warrants a report for the record.

The scant literature is reviewed. The common lesions with which *bacteroides* have been associated have been inflammatory ones of the nose, ear, pharynx, tonsils and urinary and intestinal tracts. The present case is that of a farmer aged 32 with a chronic discharge from the ear since he was 4 years of age. He had had one operation, probably for a polyp. He noticed pain radiating from the ear on July 1, 1938; on July 17 he had a chill accompanied by sweating and vomiting. On July 24 he consulted a physician and was hospitalized. The scleras were icteric, the pupils and the ocular movements normal and the disks perhaps slightly hazy; the hemoglobin content was 79 per cent and the leukocyte count 16,000; diplococci and staphylococci were present in the aural discharge. The tempera-

ture fluctuated from 98 to 103 F. Sixty grains (3.9 Gm.) of sulfanilamide was given daily. The icterus became more marked, the neck rigid and the tip of the left mastoid tender. In the left ear a whisper was heard at 2 inches (5 cm.) and in the right at 15 feet (4.6 meters). Perception in the Weber test was lateralized to the left. The left membrana tympani was perforated in the posterior half; foul pus was coming from between pale granulations. The liver and spleen were palpable. No vertigo or disturbance of equilibrium was present. There were pain in the chest and a severe cough producing scant sputum with many organisms, one of which was *Bacillus fragilis*. The facies was normal. The right mastoid was well pneumatized, and the left had no cellular development but an area of lessened density posterior to the antrum; the chest was clear except for accentuated bronchial markings. Spinal puncture revealed yellowish fluid with 5 cells per cubic millimeter and no pus cells; culture revealed gram-positive micrococci, which were regarded as a contamination. Subsequent cultures of blood revealed colonies of *B. fragilis*. The patient improved temporarily but was worse on August 5, and an exploratory operation revealed extensive destruction of bone, wide exposure of the dura, which was bile stained, an organized perisinus abscess and no lumen. Many bacteria were found, but anaerobic cultures showed *B. fragilis*. The patient experienced marked euphoria. He died on August 21.

Autopsy revealed a cerebellar abscess on the right (contralateral), purulent basal meningitis, old thrombi of the superior sagittal and petrosal sinuses, bronchopneumonia, three small abscesses (essentials only mentioned) and three small hepatic abscesses.

It is my belief that infection with bacteroides would be revealed in more cases if there was more general resort to anaerobic cultures.

#### DISCUSSION

DR. JAMES G. DWYER, New York: The moral is that in cases of chronic discharge from the ears one should make anaerobic studies on material from the ears and on the blood. The organism is not a primary invader and does not attack a previously healthy person. The same is true of *Bacillus pyocyaneus*. If anaerobic cultures were made in cases of abscess of the brain and of sinus thrombosis higher bacteria would probably be found. The presence of these bacteria is analogous to that of *Streptococcus* in actinomycosis of the lung. The icterus, due to metastases to the liver, is interesting.

#### THE FREQUENCY OF INCREASED NYSTAGMUS TIME AFTER ROTATION IN CASES OF MULTIPLE SCLEROSIS. DR. PAGE NORTHINGTON, New York.

The report represents a survey of 2,000 case reports. To induce nystagmus by rotation ten turns were used in twenty seconds. In the cases of spontaneous nystagmus the postrotatory nystagmus was observed with the eyes in the position in which the spontaneous nystagmus was not apparent. The literature is reviewed. Duration of nystagmus for more than thirty seconds is considered hyperactivity. Records are cited of over 200 student aviators with only 3 having nystagmus beyond this limit; Malan reported among 11,000 normal subjects only 7.12 per cent in whom nystagmus lasted over thirty seconds. The average for the army is twenty-four seconds, with thirty-four seconds as the upper limit. The results showed that prolonged postrotatory nystagmus occurred with multiple sclerosis in 77 per cent of the cases, with psychoneurosis in 19 per cent, with arteriosclerosis in 22 per cent and with intracranial tumors in 27 per cent.

Spontaneous nystagmus occurred with multiple sclerosis in 63 per cent, with psychoneurosis in 18 per cent, with arteriosclerosis in 18 per cent and with intracranial tumors in 42 per cent.

The hearing of patients with multiple sclerosis compared favorably with the hearing of a normal group.

Prolonged postrotatory nystagmus occurs with multiple sclerosis with greater frequency even than spontaneous nystagmus.

Further observation is being made in cases of prolonged postrotatory nystagmus in which the condition was diagnosed as psychoneurosis. Some of the patients may prove to have an organic lesion.

#### DISCUSSION

DR. STANLEY M. DILLENBERG, New York: Multiple sclerosis is being used as a scrap basket for numerous neurologic syndromes. Charcot's syndrome is seldom seen early. Symptoms referable to the pyramidal tract are often missing, and abdominal reflexes are lost in only 80 per cent of cases. Prolonged postrotatory nystagmus, present in 77 per cent, compares favorably with the absence of abdominal reflexes as a diagnostic sign. Urinalysis and examinations of spinal fluid, including the colloidal gold and other chemical tests, usually leave one in doubt. At present research is in progress to find a means of determining abnormalities in the cholesterol, lecithin and esterase content of the blood and spinal fluid or a serologic test similar to the Wassermann. A carefully taken history helps. The course is usually intermittent, with temporary dysesthesia, diplopia, blindness, numbness and fleeting disturbances of the sphincter. If the future confirms Dr. Northington's observation, a diagnostic weapon of no little importance is provided. The pathologic picture of multiple sclerosis is degenerative demyelination; hence I agree that the prolonged nystagmus is due to removal of inhibition and is central. The psychoneurotic group with prolonged nystagmus is being followed. Only 2 patients have been checked so far, and they do not show evidence of an organic lesion.

#### REPORT OF THE CHICAGO COMMITTEE ON OTOGENIC MENINGITIS, 1939. DR. ALFRED LEWY, Chicago.

The report this year was intended to deal with pneumococcic meningitis. Because of interest, two other conditions are included:

1. In the case of a boy 1 year of age, the type IV pneumococcus was cultured from the spinal fluid and blood. Bilateral mastoidectomy was performed. Type IV rabbit serum and sulfapyridine (2-[paraaminobenzenesulfonamido]-pyridine) were given. The patient recovered.

2. Meningitis due to the type XVIII pneumococcus followed a sphenoethmoid operation. Type XVIII rabbit serum was given intraspinally and intravenously, with sulfapyridine therapy, intraspinal injections of air and blood transfusions. The patient recovered.

3. A girl aged 10 years suffered from a septic condition with elevation of temperature. The ears were at first normal, but a Tobey-Ayer test indicated block of the left jugular vein and roentgen examination showed coalescent mastoiditis on the left. Mastoidectomy was performed with removal of a purulent thrombus in the lateral sinus and ligation of the jugular vein. Culture of the spinal fluid showed *Streptococcus viridans*. There was intermittent fever, the temperature sometimes reaching normal, and once the spinal fluid was sterile. Later apicectomy was performed. Therapy was attempted at first with sulfanilamide and later with sulfapyridine; blood transfusions were given. The course of the disease was fluctuating and prolonged, with a downward tendency. Cerebellar exploration gave negative results. The patient died after several months. No postmortem examination was performed.

4. A 20 year old woman had mastoiditis and meningitis; mastoidectomy was performed. Culture of material from the mastoid showed *Streptococcus haemolyticus* and that from the spinal fluid a gram-positive diplococcus, believed to be a mutation form of the streptococcus. Sulfanilamide therapy resulted in recovery.

5. A 3 year old boy had mastoiditis and meningitis. Culture from spinal fluid showed type III pneumococcus. Mastoidectomy and sulfanilamide therapy brought about recovery.

6. Four patients with pneumococcic meningitis not otogenous recovered under sulfapyridine therapy.

*Conclusions.*—Sulfanilamide appears to be useful against the type III pneumococcus. For infection of the meninges with other pneumococci sulfapyridine appears to be the remedy of choice, supplemented by the appropriate serum, which should in part be administered intraspinally. Perhaps intravenous use of sodium sulfapyridine will obviate gastric distress. Intraspinal injections of air may have value in preventing spinal block.

# Directory of Otolaryngologic Societies \*

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## FOREIGN

### COLLEGIUM OTO-RHINO-LARYNGOLOGICUM AMICITIÆ SACRUM

President: Dr. Louis Ledoux, Brussels, Belgium.

Secretary: Prof. Dr. C. E. Benjamins, Verlengde Heereweg 143, Groningen, Netherlands.

### HUNGARIAN OTOLARYNGOLOGICAL SOCIETY

President: Dr. V. Zimányi, Zárda-u. 48, Budapest II.

Secretary: Dr. G. Kelemen, Reáltanoda-u., Budapest IV.

### SOCIEDAD RIOPLATENSE DE OTO-RHINO-LARINGOLOGÍA (ARGENTINE SECTION)

President: Dr. Raul Becco, B. Mitre 1690, Buenos Aires.

Secretary: Dr. Juan Manuel Tato, Santa Fé 1171, Buenos Aires.

### SOCIÉTÉ FRANÇAISE D'OTO-RHINO-LARYNGOLOGIE

Secretary: Dr. Henri Flurin, 19 Avenue Mac-Mahon, Paris, 17<sup>e</sup>.

## NATIONAL

### AMERICAN MEDICAL ASSOCIATION, SCIENTIFIC ASSEMBLY, SECTION ON LARYNGOLOGY, OTOTOLOGY AND RHINOLOGY

Chairman: Dr. A. W. Proetz, 3720 Washington Blvd., St. Louis.

Secretary: Dr. Leroy A. Schall, 270 Commonwealth Ave., Boston.

Place: New York. Time: June 10-14, 1940.

### AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Frank Brawley, 30 N. Michigan Ave., Chicago.

Executive Secretary: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.

### AMERICAN BRONCHOSCOPIC SOCIETY

President: Dr. Lyman Richards, 319 Longwood Ave., Boston.

Secretary: Dr. Paul H. Holinger, 1150 N. State St., Chicago.

### AMERICAN LARYNGOLOGICAL ASSOCIATION

President: Dr. James A. Babbitt, 1912 Spruce St., Philadelphia.

Secretary: Dr. Charles J. Imperatori, 108 E. 38th St., New York.

Place: Westchester Country Club, Rye, N. Y. Time: May 27-29, 1940.

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\* Secretaries of societies are requested to furnish the information necessary to keep this list up to date.



AMERICAN LARYNGOLOGICAL, RHINOLOGICAL AND OTOLOGICAL SOCIETY, INC.  
President: Dr. Lee M. Hurd, 39 E. 50th St., New York.  
Secretary: Dr. C. Stewart Nash, 708 Medical Arts Bldg., Rochester, N. Y.  
Place: Waldorf-Astoria Hotel, New York. Time: June 6-8, 1940.

#### SECTIONS:

Eastern.—Chairman: Dr. John R. Simpson, Medical Arts Bldg., Pittsburgh.  
Place: Pittsburgh. Time: Jan. 5, 1940.  
Southern.—Chairman: Dr. Walter J. Bristow, Doctors Bldg., Columbia, S. C.  
Place: Columbia, S. C. Time: Jan. 8-9, 1940.  
Middle.—Chairman: Dr. Sam E. Roberts, Professional Bldg., Kansas City, Mo.  
Place: Kansas City, Mo. Time: Jan. 19, 1940.  
Western.—Chairman: Dr. Pierre Viole, 1930 Wilshire Blvd., Los Angeles.  
Place: Los Angeles. Time: Jan. 26-27, 1940.

#### AMERICAN OTOLOGICAL SOCIETY

President: Dr. Horace Newhart, 527 Medical Arts Bldg., Minneapolis.  
Secretary: Dr. Thomas J. Harris, 104 E. 40th St., New York.  
Place: Westchester Country Club, Rye, N. Y. Time: May 30-31, 1940.

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## News and Comment

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#### AMERICAN BOARD OF OTOLARYNGOLOGY EXAMINATION

The American Board of Otolaryngology will hold an examination at the Manhattan Eye, Ear and Throat Hospital, New York, June 3, 4 and 5, 1940.

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## PETROUS PYRAMID OF TEMPORAL BONE

### PNEUMATIZATION AND ROENTGENOLOGIC APPEARANCE

J. R. LINDSAY, M.D.

CHICAGO

The routine histologic examination of temporal bones has served to determine important fundamental facts regarding the intracranial extensions of otitic suppuration.

The most important fact to be established has been that in the majority of cases fatal meningitis from acute suppuration of the middle ear has resulted from deep-seated foci of suppuration in the pyramid. These foci have in most cases not been reached by the exenteration of the mastoid cells, while in some cases, because of deep location and atypical symptoms, the otogenic origin of the meningitis has been completely overlooked until proved by the histologic examination.

Next in importance is the established fact that foci of suppuration in the petrous pyramid have occurred almost always in cases in which pneumatization of the pyramid was present. Exclusive of diffuse suppurative labyrinthitis and hematogenous metastatic foci in bone marrow, the occurrence of foci of suppuration has been found to depend on the presence of pneumatized areas. While such foci may become large, with extensive destruction of bony walls and invasion of adjacent marrow spaces and even of adjacent bones of the skull, the lesion begins as suppuration in pneumatic spaces from which drainage is inadequate or becomes partially or completely blocked off. The pathologic process is the same as in suppuration in mastoid cells, but since there is always more or less bone marrow in the petrous pyramid it is common to find some invasion of marrow spaces as a part of the destructive lesion.

Acute or chronic osteomyelitis of the petrous pyramid was found in my material only in cases in which pneumatized areas were present. The focus of suppuration had developed primarily in pneumatized areas in all instances.

Accurate knowledge of the location of pneumatized areas and the routes by which they develop is therefore of primary importance,

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From the Division of Otolaryngology of the Department of Surgery of the University of Chicago.

The material for this report was presented in a scientific exhibit at the Ninetieth Annual Session of the American Medical Association, St. Louis, May 15-19, 1939.

because this information must be the basis for correct interpretation of clinical symptoms and signs, the proper technic for visualization of the various areas roentgenologically and the type of surgical procedures which must be adopted to remove or drain the focus of suppuration adequately.

Suppurative disease of the apex of the petrous pyramid has been recognized in isolated cases by the early otologists and has been discussed in the early literature by Troeltsch, Bircher, Urbantschitsch and Habermann.

Pneumatization of the temporal bone was studied by Siebenmann shortly after the turn of the century. In more recent years the recognition of the fact that suppuration of the pyramid is frequent and closely related to the presence of pneumatized areas has led to many anatomic studies. The methods used have included the corrosion technic, the study of gross specimens, roentgen examination and the study of serial sections of the temporal bone.

Of these methods, the latter is the only means at present of obtaining reliable and detailed information regarding the presence, location and connections of pneumatized areas and the routes by which they have developed.

The material on which the following studies on pneumatization have been made consists of serial sections of 100 temporal bones from patients from 4 years of age and upward. The histologic material used to demonstrate suppurative foci in the various pneumatized areas has been partly described in a previous publication<sup>1</sup> and has been accumulated since 1930. The roentgenograms used to demonstrate correlation of structure, pathologic condition and roentgen appearance are chosen mainly from cases in which the condition was acute and the findings were proved at operation. Partly because the observations on pneumatization have been found to be at considerable variance with those described in previous reports and partly because the results have an important and direct bearing on surgical procedures, it is necessary to give a somewhat detailed description of the pneumatized areas and the routes by which they develop.

The discussion of chronic suppuration in the petrous pyramid and the interpretation of roentgenograms in the presence of such conditions are not included in this report.

As there is still some variation in the terms used to describe the position both of the pyramid as a whole and of the various pneumatized areas within the pyramid, some clarification of terminology is needed.

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1. Lindsay, J. R.: Suppuration in the Petrous Pyramid, *Ann. Otol., Rhin. & Laryng.* **47**:3, 1938.

The terminology chosen is that which is most practical from the standpoint of the otologist and corresponds closely to that suggested by Mayer.<sup>2</sup> The surface of the pyramid which borders on the middle fossa is called superior; that bordering on the posterior fossa is medial. The apex lies anterior and the base of the pyramid posterior.

When considered from the standpoint of the otologist the petrous pyramid falls naturally into two main parts, the perilabyrinthine region and the petrous apex. This division is convenient both because of the pattern of pneumatization and because of the different clinical and surgical problems created by suppuration in these two areas.

The perilabyrinthine areas lie anterior to the plane of the superior semicircular canal and the descending portion of the facial canal and extend anteriorly to the cochlear capsule and the internal auditory meatus. On roentgen examination the superior semicircular canal marks the posterior boundary of the perilabyrinthine area. Part of the labyrinth extends posterior to the plane of the superior canal and has been called the periantral area (Mayer), but from a practical point of view this area may be considered as part of the mastoid problem.

The perilabyrinthine areas which are commonly pneumatized may therefore be considered as superior, inferior and medial. The prefix "postero-" could be added to any of these areas to distinguish the location from similar regions of the apex.

The term "apex" is used to denote that part of the pyramid lying anterior to the cochlear capsule and the internal auditory meatus but medial to the carotid canal. The term "peritubal" is reserved for the cells surrounding the eustachian tube and lying lateral to the carotid canal.

This interpretation of the term "apex" is preferable from the clinical viewpoint, as suppuration in any part of this area will produce the same clinical and surgical problem and should therefore be classed under one heading, namely, "apicitis" or "suppuration of the apex." Also this interpretation of the term "petrous apex" is analogous to the common use and interpretation of the term "mastoid tip" and is equally correct.

Peritubal cells, which lie lateral to the carotid canal, because of their close relation to the tympanum or the eustachian tube, have more direct drainage and are rarely the cause of a complication. The distribution of these cells has been studied in as much detail as the material would permit, but a detailed description is not within the scope of this report.

The percentages given are those found in the 100 specimens examined. There might be considerable variation in percentages if a

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2. Mayer, O.: Die Pyramidenzelleneiterungen, Ztschr. f. Hals-, Nasen- u. Ohrenh. 42:1, 1937.

larger series were examined, but the conclusions which may be drawn from this series would remain the same, as the surgical measures to be adopted must be adequate for all anatomic variations.

The roentgenograms which are presented have, with the exception of fig. 7 *a* and *b*, been prepared in the University of Chicago Clinics' department of roentgenology under the direction of Prof. Paul C. Hodges.<sup>3</sup>

#### THE PERILABYRINTHINE AREAS

1. *The Superior (or Posterosuperior) Area*.—Pneumatization was present in 36 per cent of the specimens. The origin of cell tracts pneumatizing the superior area was as follows:

From the epitympanum only, no connection with the mastoid cells (figs. 1, 2 <i>a</i> and 3 <i>b</i> ) .....	18%
From the epitympanum, plus a tract from the mastoid, in the "angle" or over the superior semicircular canal (fig. 2 <i>b</i> ) ...	9%
From the epitympanum, plus a tract through the subarcuate region .....	4%
From the mastoid only, through the angle.....	2%
From the mastoid only, through the subarcuate region (fig. 3 <i>a</i> ) .	3%
Total .....	36%

It is apparent from these figures that the superior area is frequently pneumatized and that the primary route is from the epitympanum directly.

In less than half the pneumatized specimens there was pneumatization both from the epitympanum and from the mastoid, while in a few cases there existed only a tract from the mastoid, either along the angle or through the subarcuate fossa.

In specimens in which pneumatization occurred both from the epitympanum and by a tract from the mastoid, the two tracts remained entirely separate, although divided by a thin bony wall. Exceptions to this occurred in at least 2 cases of suppuration of which histologic examination was made in 1 and the observations verified by operation in 1, but the communication in both cases may have been due to the suppuration.

For this report only specimens in which the pneumatization had reached as far as the superomedial angle have been recorded as pneumatized. The clinical and surgical importance of these observations is at once apparent. A focus of suppuration may exist in the superior

3. For details as to the roentgen technic used the reader is referred to an article by P. C. Hodges (*An Apparatus for Stereoscopic Roentgenography of the Skull*, *Am. J. Roentgenol.* 42:921 [Dec.] 1939).

cells and be completely walled off from the mastoid by the dense bone of the labyrinthine capsule. Such was the condition revealed by histologic examination in 3 fatal cases in my experience, while in a fourth the only communication to the superior area was through the subarcuate region (figs. 1, 2 and 3).



Fig. 1.—Above, on the left, the superior area (*E*) is seen to be well pneumatized. These cells developed from the epitympanum only (*A*). The section on the right shows how the superior canal (*S. C.*) separates the superior cells from the mastoid. There is beginning pneumatization through the subarcuate fossa from the mastoid, which does not reach the superior cells. The patient died of meningitis, by extension of suppuration in the superior cells of the opposite ear. Below, suppuration in the superior area, *A* (left), extended to the middle fossa. This area was pneumatized from the epitympanum (*E*) only. The superior canal, *S. C.* (right), formed a complete barrier between the diseased area and the mastoid cells. New formation of bone is seen at *B*.



Fig. 2.—Vertical longitudinal section (a) of a pyramid, showing a pneumatized superior area, *A*, separated entirely from the mastoid, *B*, by the semicircular canals, *S.C.* The cells, *A*, developed from the epitympanum. The superior cell area in *b* has been pneumatized from two sources. Cell *A* has developed from the mastoid; cells *B*, from the epitympanum. These tracts have remained separate.

**Roentgenologic Appearance:** The roentgen examination usually gives reliable information regarding the superior area. The projection which allows best visualization is Stenvers' view or some of the modifi-

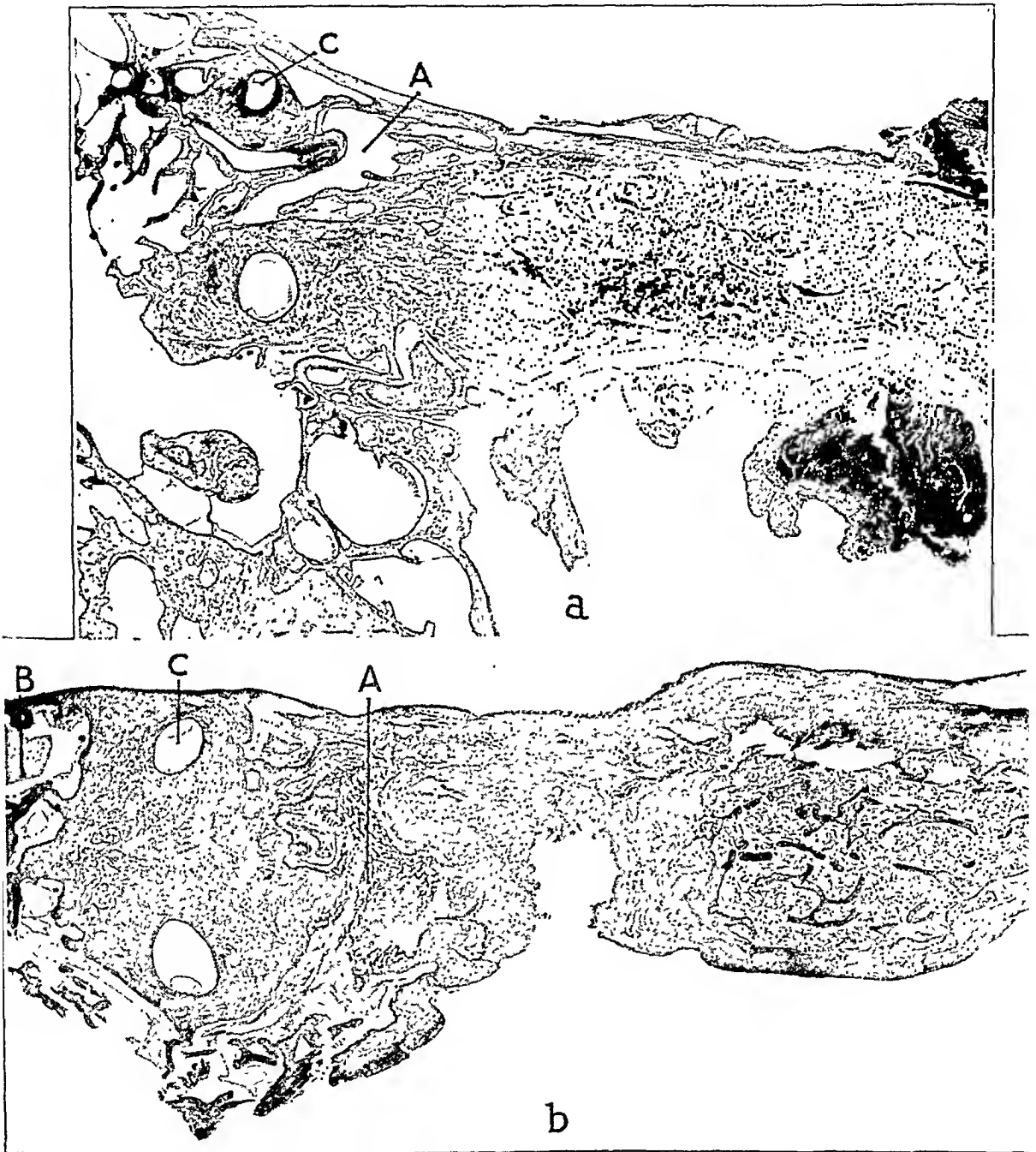


Fig. 3.—In *a* pneumatization of the superior angle, *A*, through the subarcuate region only is seen. The cells in the angle border both on the superior and the medial surfaces of the pyramid. The superior canal is seen at *C*. In *b* suppuration has invaded the superior area, *A*, from the epitympanum, with extension to the meninges. The superior canal, *C*, separates the area from the mastoid cells, *B*.

tions of it. This view shows the superior canal clearly and may indicate whether a cell tract exists between the canal and the cortex. It shows pneumatization in the superior area, if present, and is also the best



view to show an extension of the superior perilabyrinthine cells into the superior part of the apex (figs. 4 and 5 *a* and *b*).

It is important to realize, however, that this view does not show pneumatization in the posteromedial perilabyrinthine area, unless that pneumatization reaches up to the region of the superior angle (to be

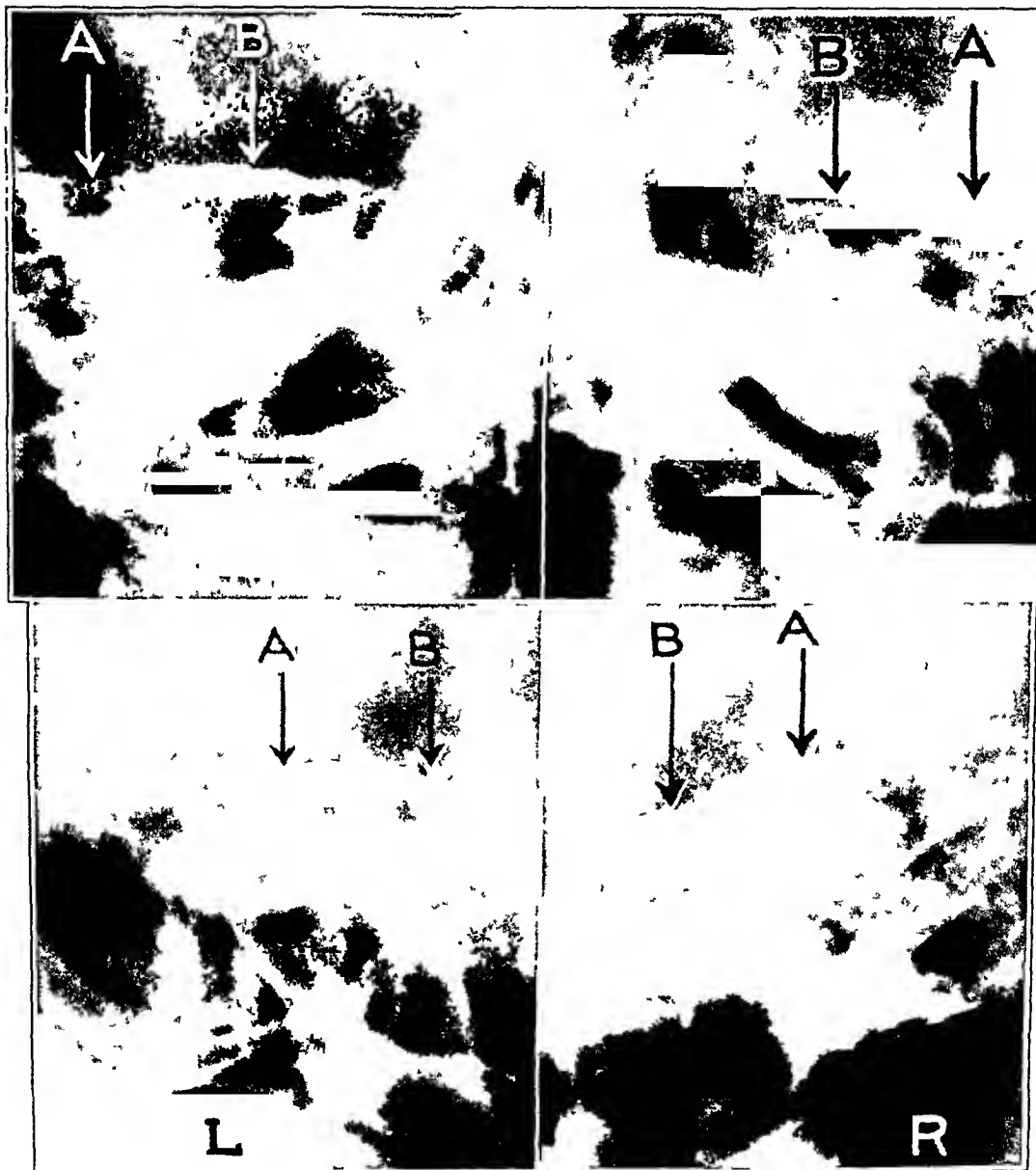


Fig. 4.—Above, Stenvers' projection, showing pneumatization of the superior area, *A*, on both sides, extending into the apex. There is definite asymmetry, a common finding in pneumatized pyramids. Below, pneumatized superior area, *A*, on the right, with decreased density of the apex, *B*. (On the axial view cell outlines can be seen) The corresponding areas on the left are dense. Prolonged suppuration in the left ear persisted after complete mastoidectomy.

illustrated later). Also, in my experience, when the apex is pneumatized only in the lower levels, which is a frequent observation, Stenvers' projection does not show up these areas as reliably as the axial (mento-vertical) view.

Another method which gives information regarding the superior area is the transorbital frontodorsal projection. This view has the advantage of being easier to obtain, for instance in very young children,

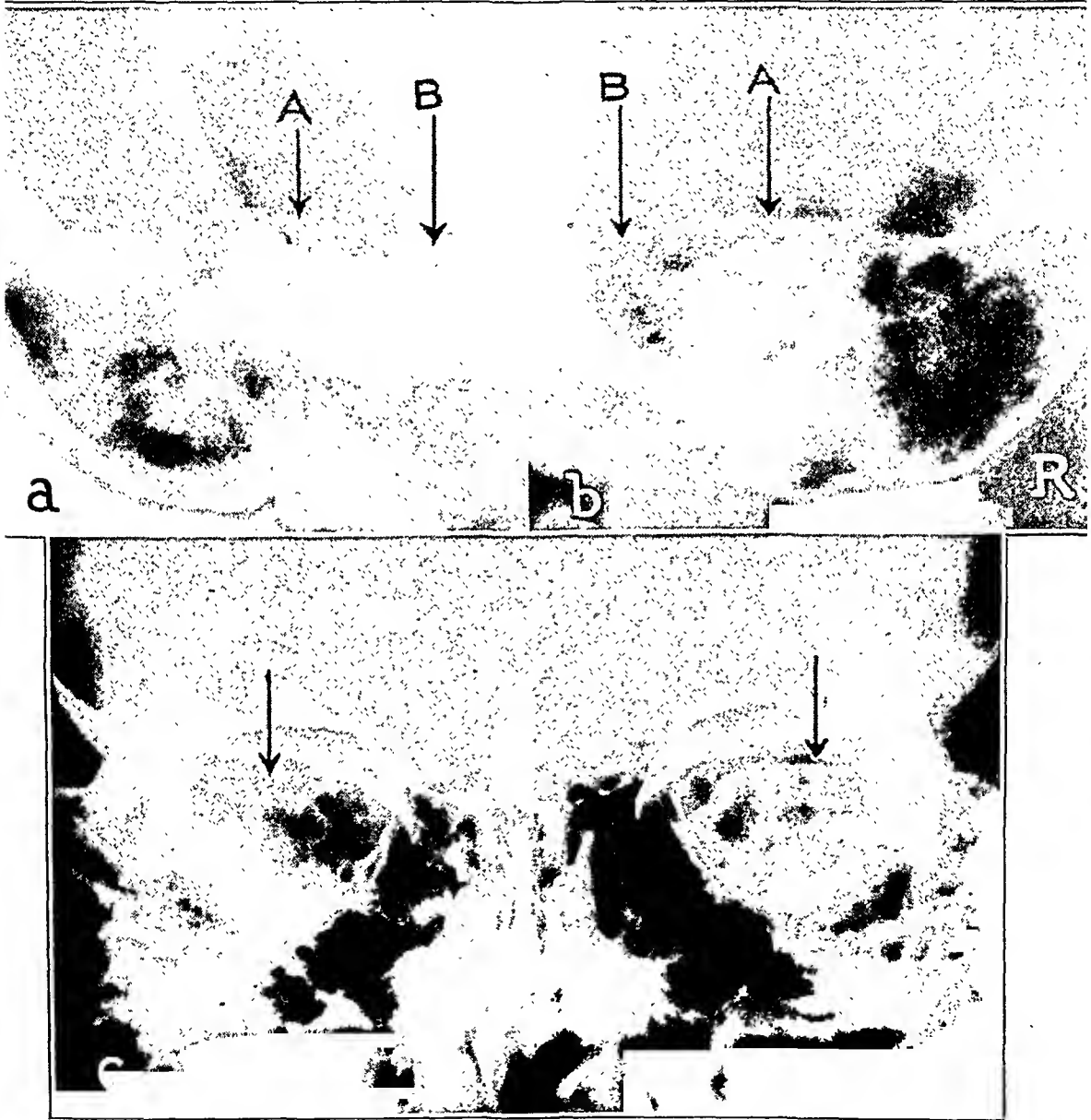


Fig. 5.—Stenvers' projection (*a* and *b*), showing asymmetry of the petrous pyramids. The superior area, *A*, is pneumatized on both sides, but dense on the left. The apex, *B*, is pneumatized on the right, and cells extend to the superior border, suggesting that the apex has been pneumatized, at least in part, from the superior cells. The apex on the left appears dense. The patient had tuberculous otitis. Transorbital view (*c*), showing pneumatization of superior areas and apices and asymmetric pneumatization of the pyramids.

and shows both sides with the one exposure, but has the disadvantage of being an oblique projection, while at the same time failing to show the apexes completely and also the periantral and the mastoid region (fig. 5 c).

2. *The Posteromedial (or Medial) Area.*—Pneumatization was present in 25 per cent of the specimens.

This group includes only specimens in which a cell tract extended from the mastoid anteriorly between the aquaeductus endolymphaticus and the posterior fossa. Specimens in which only the cells in the superior angles reached the cortex of the posterior fossa are grouped with those having pneumatization in the superior cell area, because the diagnostic and surgical problem is the same.

Pneumatization of the posteromedial tract was seen in bones in which a large amount of periosteal bone has been laid down on the posteromedial (medial) surface of the labyrinth, making it possible for pneumatization to develop forward from the mastoid between the aquaeductus endolymphaticus and the cortex, thus bordering on the posterior fossa (figs. 6, 7 and 8).

Since this area is pneumatized from the mastoid, suppuration must reach it by way of mastoid cells, but it is not uncommon to find that the tract by which the infection entered the area is obliterated sufficiently to escape gross inspection at operation. In such cases roentgenologic information is indispensable as an indication that a focus of suppuration lies deeper (fig. 7 c).

Roentgenologic Appearance: Stenvers' view will show pneumatization in the posteromedial area only if the cells extend into the superior angle.

The most useful view to show this area in all cases is the fronto-dorsal projection, which was first presented by Grashey and which is referred to throughout this report as the "occiput-down view." Many variations of this view have since been described. Pneumatized tracts which extend along the medial border of the pyramid but which may not reach the superior angle are shown clearly by this view (fig. 7 c).

The axial projection first described by Schuller, in 1905, also shows the posteromedial cell tract, but less clearly than the previous view (figs. 8 c and 7 c).

Surgical Application: An illustration of the value of accurate roentgenologic information is shown in figure 7 c, which was made in a case in which otitic meningitis due to infection with *Pneumococcus* type III extended from a coalescent abscess in the posteromedial cells on the right side into the posterior fossa. The abscess was cleaned out surgically, but it was only after curetting anteromedially beyond the level of the posterior semicircular canal through about 1 cm. of bone partly sclerotic that the abscess was entered.

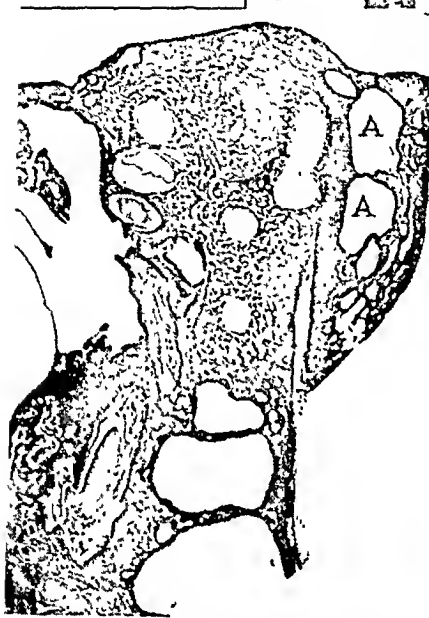
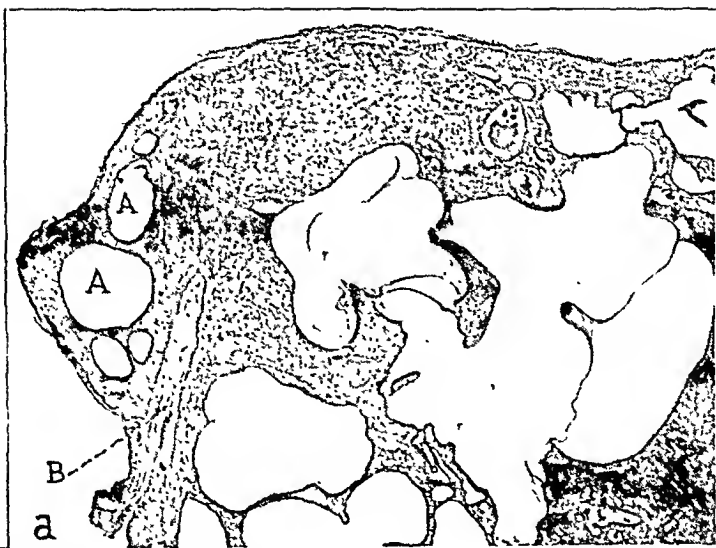


Fig. 6.—Vertical section (*a*) through the middle ear, showing a pneumatized posteromedial area, *A*, which lies between the aqueductus endolymphaticus, *B*, and the posterior cranial fossa. These cells lie well below the superior angle of the pyramid. The posteromedial cells, *A*, are well developed in *b*. The area does not reach as high as the labyrinth and would, therefore, not be evident on Stenvers' roentgen projection. Meningitis resulted in *c* from extension of an abscess, *A*, in the posteromedial area into the posterior cranial fossa. The aqueductus endolymphaticus is seen at *B*.

Stenvers' views (figs. 8 *a* and *b*) gave no suspicion of the location of the abscess in this case, but the other views indicated clearly the area to be explored surgically (figs. 7 *c* and 8 *a* and *b*).



Fig. 7.—In *a* and *b* the superior cell area is pneumatized on the right, the cells extending into the superior angle of the apex. The superior perilabyrinthine area on the left is clouded, but in the superior part of the apex is a large area of decreased density with an erosion through the ridge. The presence of this necrotic area was verified at operation. Not seen on Stenvers' view, however, was a well developed posteromedial group of cells which was a part of the necrotic focus and allowed surgical drainage of the area from the mastoid. The occiput-down view (*c*) is from another case, illustrating a well pneumatized posteromedial cell area, *A*, on both sides, with increased density on the right. The mastoid cells also are well shown and are clouded on the right. An abscess was found at *A* on the right, eroding into the posterior fossa.

The posteromedial cell tract does extend up into the superior angle in a certain group of cases, and in such instances the upper part of the area shows on Stenvers' views. A good example is shown in figure

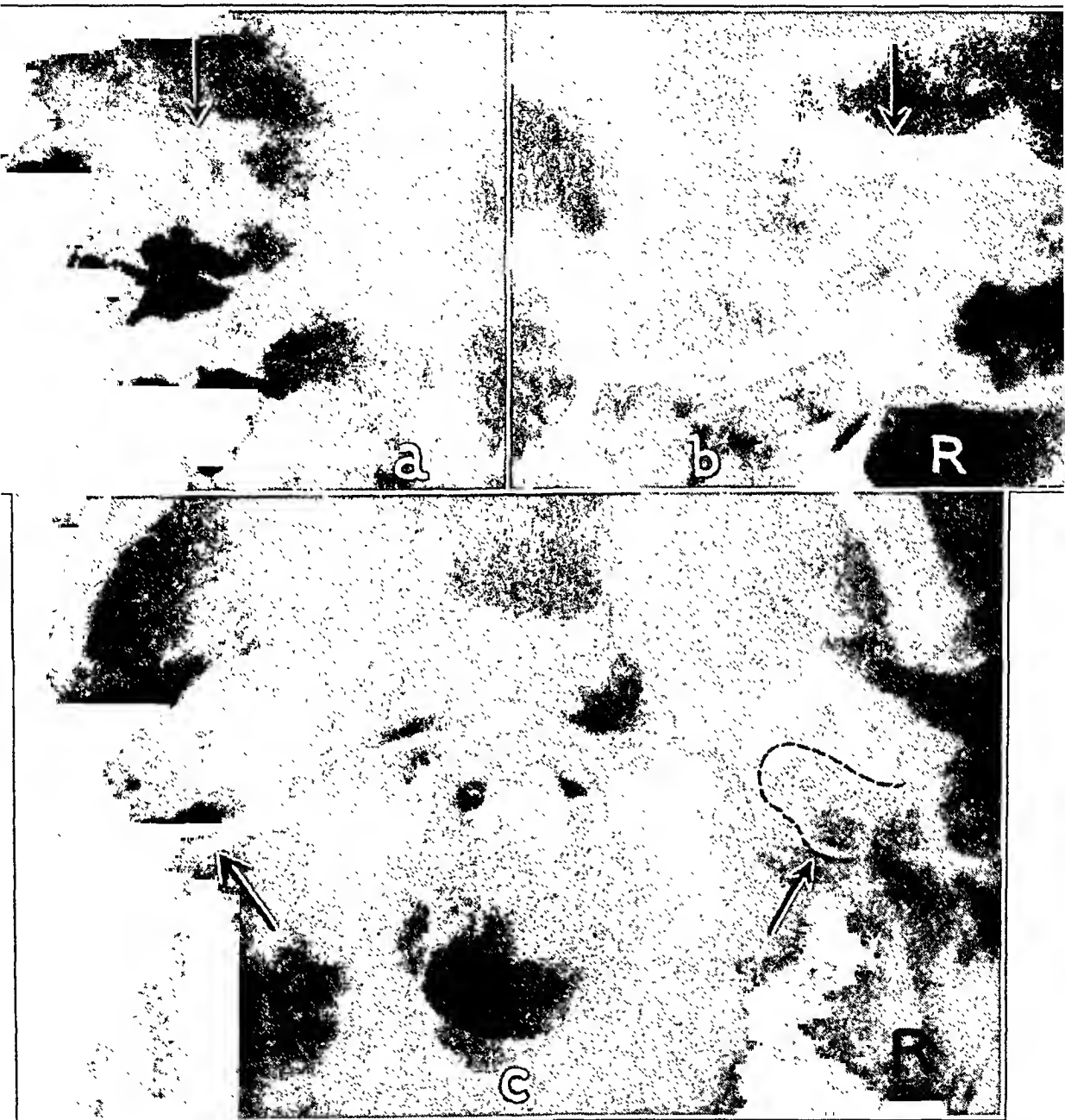


Fig. 8.—Stenvers' view (*a* and *b*) of the subject shown in figure 7 *c*. This view gives no indication of the large pneumatized posteromedial areas seen on the occiput-down view. The superior areas appear fairly symmetric. The presence of a posteromedial cell tract may be shown on the axial view (*c*) also, but the contrast is less distinct than on the occiput-down view (fig. 7 *c*). The posteromedial area lies within the dotted line on the right.

7 *a* and *b*. In Stenvers' view an area of decreased density is seen in the superior angle of the pyramid, with erosion of the cortex. Stenvers' view, however, gives only a partial picture in this case. The occiput-

down view indicated the presence of a tract of posteromedial cells not shown in figure 7 *a* and *b*, and at operation it was possible to follow this partly sclerosed tract medial to the posterior canal and forward into the necrotic area above the internal meatus. The posteromedial and superior areas, as well as the superior angle of the apex, were occupied by one necrotic mass, and the superior bony angle was eroded away.

It is evident from these illustrations, then, that Stenvers' and the occiput-down view both are necessary when a lesion in the petrous pyramid is suspected. The importance of the posteromedial perilabyrinthine cells as a common location for suppuration is shown by figures 6 *c* and 7, and the information which is to be obtained from the occiput-down view is of particular value as a guide to the surgical approach. It is always possible to reach the region from the mastoid, but, since the tract leading forward to the area may be composed of small cells or even be sclerosed, a suppurative focus might be overlooked if accurate roentgen evidence were not at hand.

#### INFRALABYRINTHINE CELLS

The infralabyrinthine area was pneumatized to some extent in 25 per cent of the specimens, which may be subdivided into groups according to the extent and origin of pneumatization:

- |                                                                                                                                                                        |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| (a) Those with a tract from the hypotympanum to the mastoid (fig. 9 <i>a</i> ) .....                                                                                   | 13% |
| (b) Those with a tract from the mastoid forward to either the jugular bulb or the round window niche but not connecting with the hypotympanum (fig. 9 <i>b</i> ) ..... | 8%  |
| (c) Those with a tract from the hypotympanum limited to the infralabyrinthine area (fig. 9 <i>c</i> ) .....                                                            | 3%  |
| (d) Those with infracochlear cells leading into the apex (fig. 12 <i>b</i> ) .....                                                                                     | 6%  |
| (e) Those with a combined tract underlying the labyrinth from the mastoid to the apex; this group is included also in group <i>d</i> (fig. 10) .....                   | 4%  |

It is evident from these figures that infralabyrinthine cells vary greatly in origin and extent.

In the majority, the pneumatized area extends from the mastoid to the jugular bulb or round window niche (groups *a* and *b*). It is evident from the figures that the area is pneumatized from the mastoid in at least a large percentage of cases, which probably creates a greater tendency for suppuration to be walled off in it than if there is an opening to the hypotympanum.

While it is understandable that simple infralabyrinthine cells (group *c*) may cause persistent drainage in chronic conditions, these



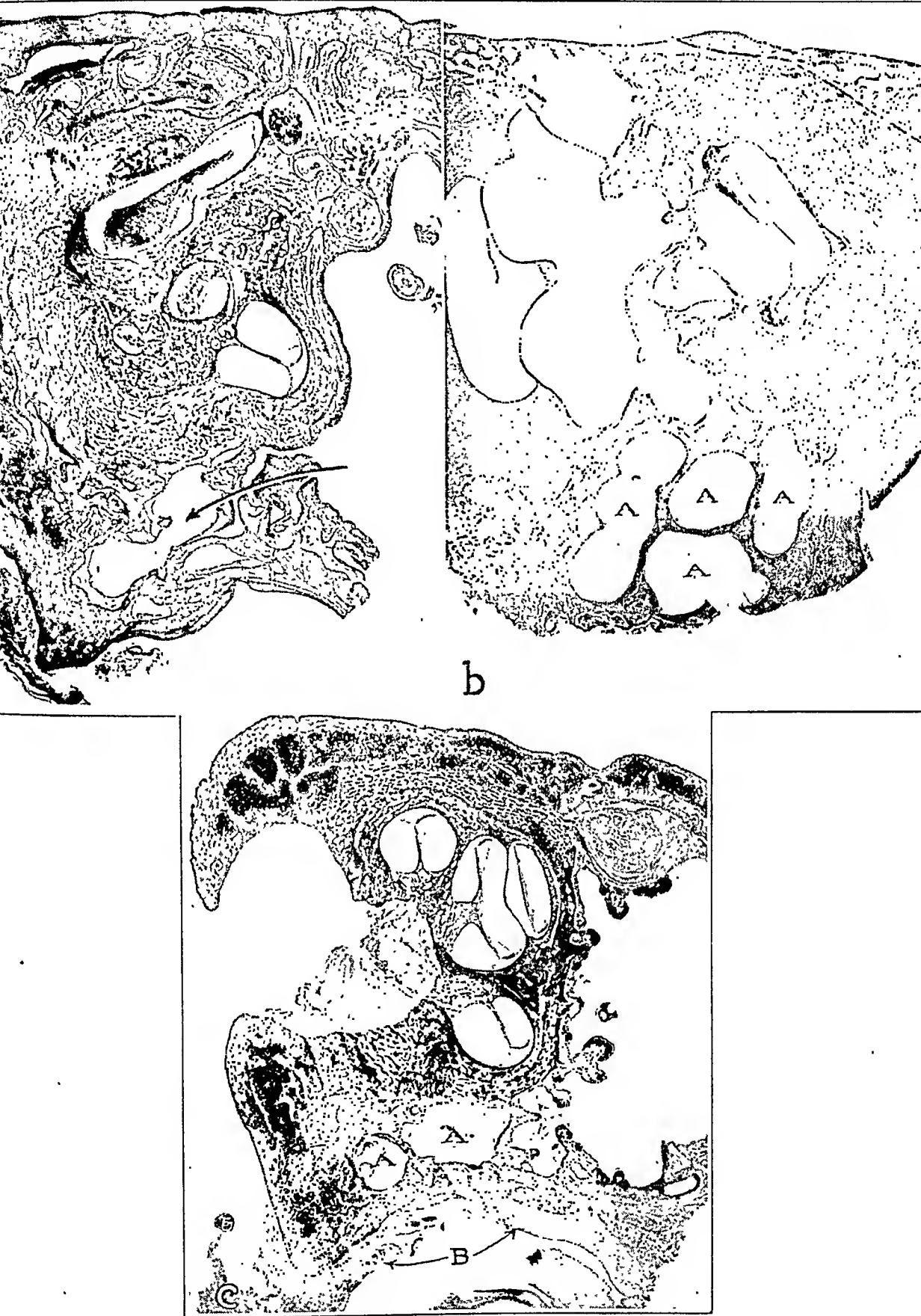


Fig. 9.—Vertical section (a) to show origin of a tract of infralabyrinthine cells extending from the hypotympanum posteriorly to the mastoid. The infralabyrinthine cell tract, *A*, in *b* developed from the mastoid and does not connect with the hypotympanum. Infralabyrinthine cells, *A*, were already present at 7 months in *c*. The patient had pneumococcic otitis media with thrombosis of the jugular bulb. The inflammatory changes in the walls of the jugular bulb, *B*, should be noted.





Fig. 10.—In this specimen the superior and posteromedial areas are not pneumatized, but the labyrinth overlies a layer of pneumatic cells throughout its length.

cells probably are seldom the cause of a complication in acute suppuration. However, figure 9 *c* shows a section from a 7 month old infant with pneumococcic otitis, thrombosis of the jugular bulb and meningitis, and it appears that the early infralabyrinthine pneumatization may have been an important factor in the development of thrombosis of the bulb. Cases have also been reported in which suppuration has invaded the aquaeductus cochlearis from infralabyrinthine cells.

Group *d* will be discussed in the section entitled "The Petrous Apex."

Group *c* comprises bones in which the labyrinth was placed at a high level against the middle fossa but rested on a bed of pneumatic cells extending from the mastoid to the apex. This type is relatively infrequent (4 per cent), a fact which limits to a low percentage of cases the possibility of reaching the apex surgically from the mastoid by the infralabyrinthine route.

The cells in these specimens were not a single tract which develops from the mastoid to the apex. As has been shown, the cells develop partly from the hypotympanum and partly from the mastoid, and therefore a direct tract from the mastoid to the apex is rare, but in the presence of suppuration and necrosis surgical entry to the apex would probably be facilitated.

*Roentgenologic Appearance.*—None of the present views are particularly satisfactory to show the infralabyrinthine cells. Because of the relation to the base of the skull a satisfactory projection has not been developed. In Stenvers' view, which is perhaps the most useful, the labyrinth partly overlies the infralabyrinthine area.

#### THE PETROUS APEX

For reasons stated previously the term "petrous apex" is used to apply to the part of the pyramid anterior to the cochlea and internal meatus and medial to the carotid canal.

The petrous apex was pneumatized in 21 per cent of the specimens, which may be classified as follows:

(a) Those pneumatized only in the superior part as an extension from the superior angle (fig. 11) .....	7%
(b) Those pneumatized from the anterior part of the tympanum and the eustachian tube (figs. 12 and 13) .....	14%
Total .....	21%

Group *a* includes all specimens pneumatized from the superior cells or the angle. In part of these, therefore, the apex was in direct connection with the mastoid, but in some its cells were extensions from the epitympanum only. Some of these specimens also had some pneumatization from the anterior part of the tympanum, but there was never any communication between the two cell tracts.

Group *b* represents the type of pneumatization studied and demonstrated with reconstructions by Anson, Wilson and Gaardsmoe.<sup>4</sup> This group showed a great variation in the extent and in the location of the tract leading into the apex. The majority contained only a few cells, which, however, were usually large. In some specimens a single large cell was present. In 1 specimen (fig. 12 *a*) the superior part of the

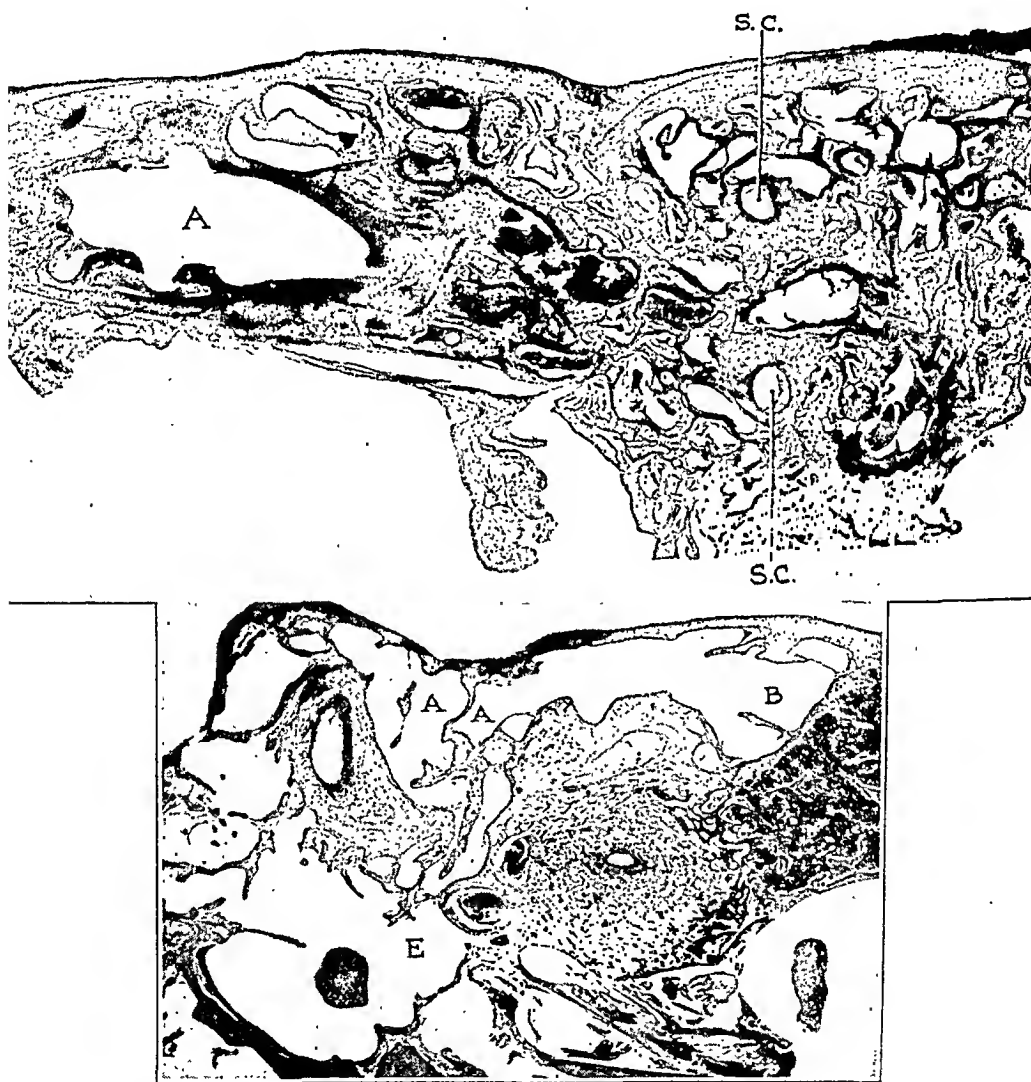


Fig. 11.—Above, suppuration reached the apex, *A*, in this specimen by way of the superior cells, which connected with the mastoid cells around the superior canal, *S. C.*, and through the subarcuate fossa. Below, pneumatization from the superior area, *A*, into the superior part of the apex, *B*. This tract developed mainly from the epitympanum, *E*.

4. Anson, B. J.; Wilson, J. G., and Gaardsmoe, J. P.: Air Cells of Petrous Portion of the Temporal Bone in a Child Four and One-Half Years Old: Study Based on Wax Plate Reconstructions, *Arch. Otolaryng.* **27**:588 (May) 1938.

apex was mostly dense bone while the lower part was extensively pneumatized. In several the pneumatization did not approach the superior surface. The tracts by which the apical cells developed included several types, namely:

1. Through the angle between the knee of the carotid canal and the cochlea.

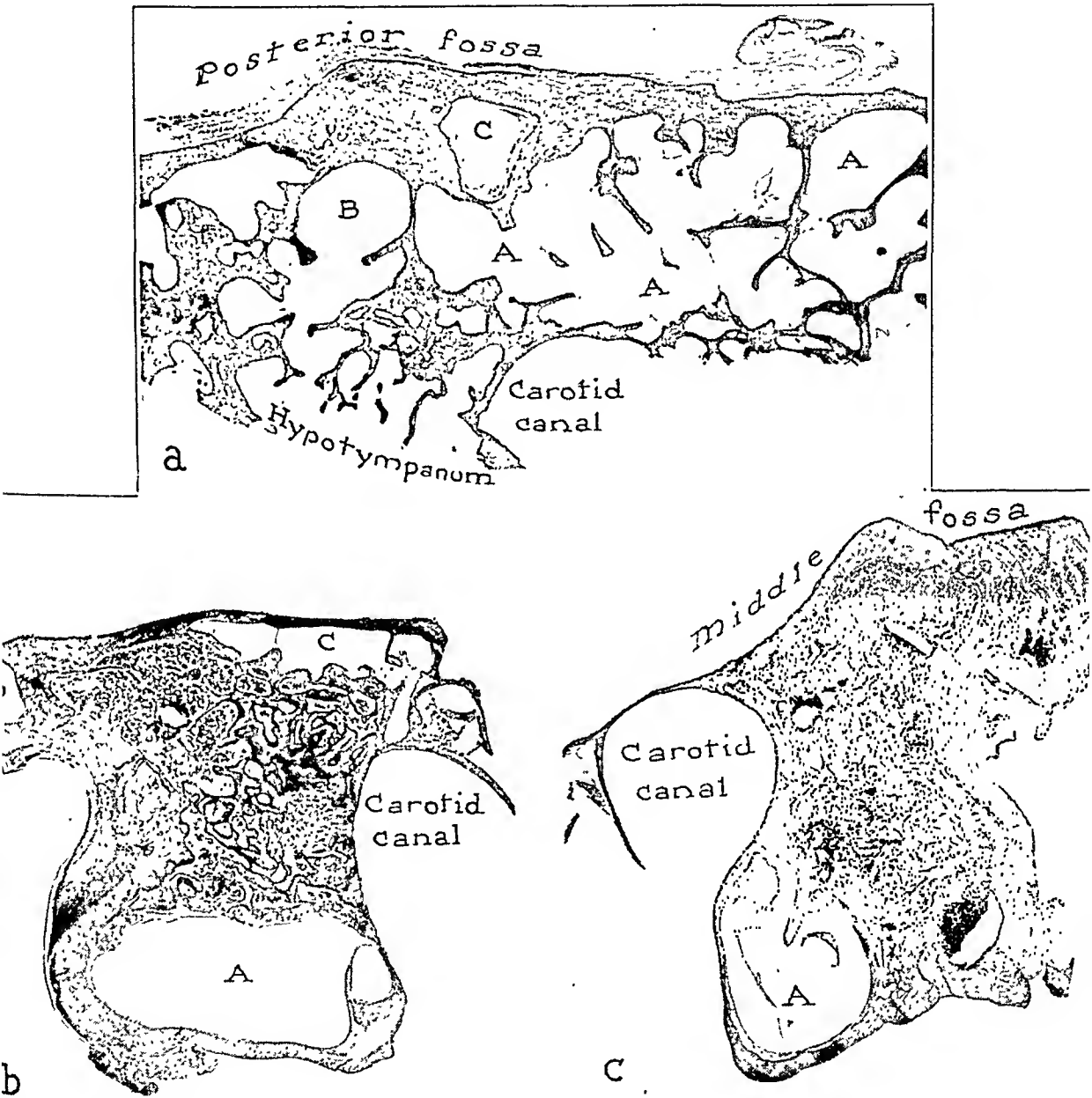


Fig. 12.—A horizontal section (a) beneath the labyrinth. The lower part of the apex, *A*, is extensively pneumatized from the hypotympanum, but the upper levels are dense bone, with only a few narrow spaces. The infralabyrinthine cells, *B*, are a separate extension from the hypotympanum. *C* indicates the cochlear aqueduct. Vertical section (b) through an apex showing three routes by which pneumatization may develop. Cell *A* came from the hypotympanum, cell *B* from the mastoid through the superior angle and cell *C* from the tympanic cavity over the knee of the carotid canal. The single large cell, *A*, in the apex shown in *c* developed from the eustachian tube, anterior to the ascending carotid canal.

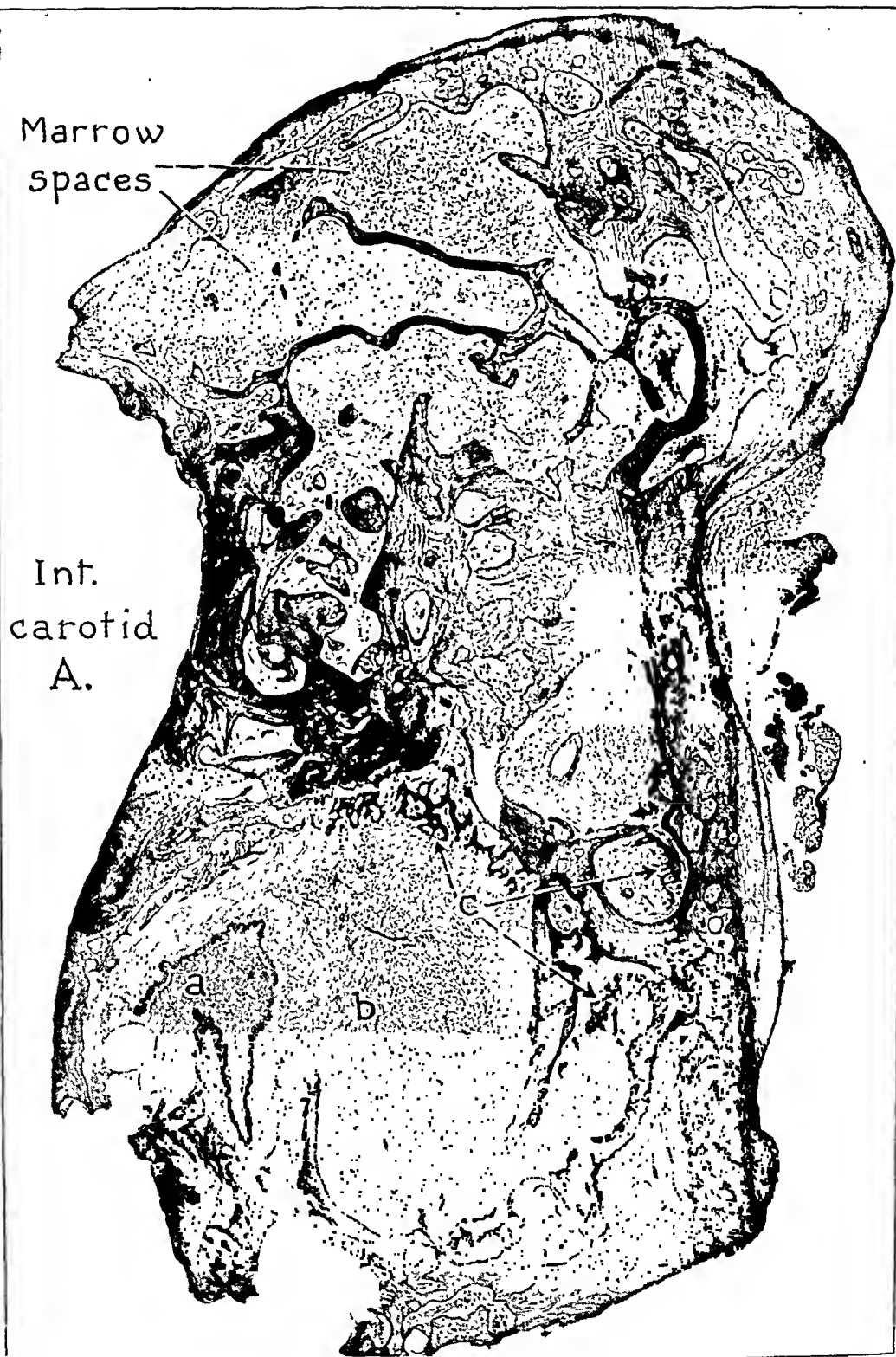


Fig. 13.—Vertical section through the apex. The focus of suppuration developed in the pneumatic space, *a*, which extended from the hypotympanum. Much tissue is seen at *b*, with osteogenesis at *c*. This area could not have been reached by way of the middle fossa or from the mastoid.

2. Beneath the cochlea and medial to the ascending carotid canal.
3. In front of the ascending carotid canal.
4. Above the horizontal part of the carotid canal.

In at least 1 specimen the tract originated from the eustachian tube rather than directly from the tympanum.

It must be realized that figures on pneumatization in all areas of the pyramid vary according to the material examined. However, to cite actual figures is of less importance than it is to establish the existence of certain general types of pneumatization with approximate percentages, so as to provide a guide for clinical interpretation and roentgen study and to form a basis for adequate surgical intervention.

*Roentgenologic Appearance.*—The petrous apex may be shown by two projections, Stenvers' view and the axial. The former requires separate exposure for each pyramid, while the latter has the possible advantage of showing both pyramids on one exposure. These two views are taken in entirely different planes, the former being approximately perpendicular to the medial surface of the pyramid and the latter perpendicular to the inferior surface. Therefore both views are necessary if the maximum information is to be obtained about the apex.

Stenvers' view is useful in indicating whether the apex is pneumatized in the superior part and usually indicates if the pneumatization is an extension from the superior cells. It is also the most useful view to show erosion of the superior angle of the apex.

The axial view, however, is best to show pneumatization of the apex from the anterior part of the tympanic cavity or tube, which usually occurs in the lower part of the apex. By this view it is often possible to determine the location of cells even when pneumatization is limited (figs. 13 and 14 *a*). The axial view, however, will not show the superior or infralabyrinthine cells.

When there is extensive pneumatization it can be easily shown by either the axial or Stenvers' projections. It is important to realize, however, that pneumatization of the apex is frequently limited to the lower half (figs. 12 and 13) and that in such cases Stenvers' view alone cannot be depended on. Both views should always be taken when the petrous apex is in question.

*Surgical Application.*—Because pneumatization of the apex develops from the perilabyrinthine areas only in the minority of cases, surgical access to the apex by way of the perilabyrinthine cell tracts from the mastoid is limited to a correspondingly small group of cases.

Access to the apex by way of the middle fossa is feasible only when there has been erosion through the superior surface of the bone

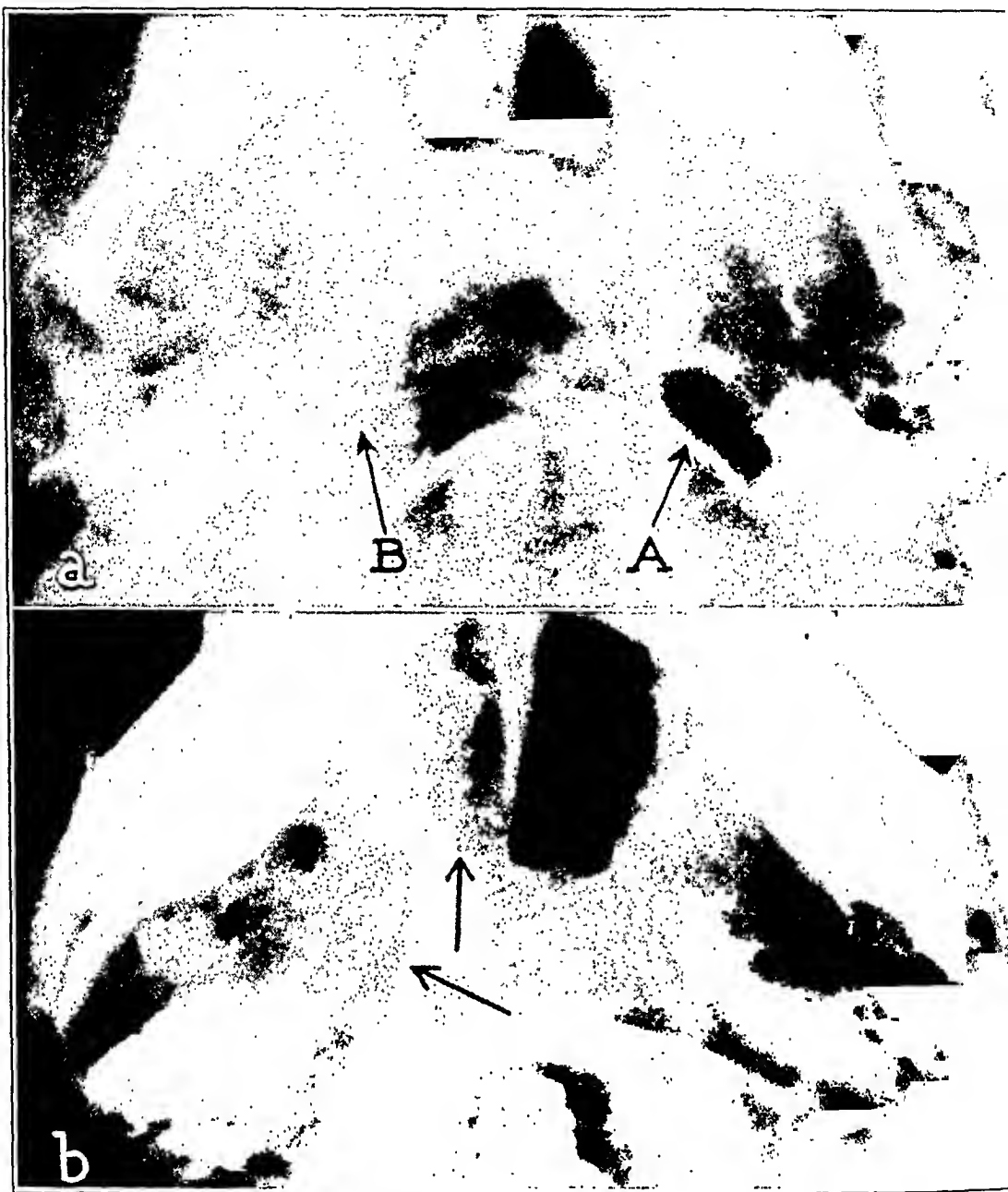


Fig. 14.—In *a* is shown acute suppuration on the right side, with signs of complication in the posterior fossa. Complete mastoidectomy was performed without improvement, after which septic temperature and bacteremia developed. Queckenstedt's sign was normal. The axial view shows that the normal apex, *A*, is partly pneumatized while the corresponding area, *B*, on the diseased side is dense. Stenvers' views failed to bring out this contrast. The operation on the apex by the approach through the eustachian tube was followed by uneventful recovery. In *b* is seen an example of suppuration in the apex with extension to the sphenoid sinus. The mucosa of the sinus was greatly thickened. Attempts to drain this apex by way of the mastoid and by way of the middle fossa were unsuccessful. The patient was treated in 1934.

or when the superior cortex is thin and the focus of suppuration directly beneath it. Histopathologic studies show that such conditions may be expected only in a minority of cases. The majority of apical cells develop from the anterior part of the tympanum or the tube, usually from the hypotympanum, and in many such cases the pneumatized area is separated from the cortex of the middle fossa by as much as a centimeter of bone, which may be relatively dense. In these cases the only feasible and rational surgical approach is by way of the middle ear and the mouth of the eustachian tube.

These figures on pneumatization correspond with my practical experiences. The apex can usually be drained adequately by the posterior approach in cases in which pneumatization has extended from the superior and posteromedial perilabyrinthine areas. These cases belong in the general group of cases of "posterior petrositis." However, suppuration in apexes which have been pneumatized from the anterior part of the tympanum (anterior petrositis) requires the anterior approach, via the mouth of the eustachian tube, for adequate drainage.

#### PERITUBAL CELLS

All cells lying above, below and lateral to the tube, as well as those between the carotid canal and the tube and those which extend medial to the carotid canal, are considered peritubal. These cells open mainly from the middle ear but in some instances open directly off the tube. In the latter instances they frequently are lined by ciliated epithelium, although this is not constant. Ciliated epithelium, however, was not observed to extend into the cells within the apex, although in some instances these may be extensions of peritubal cells.

A detailed study of peritubal cells is not included in this report, but the presence of peritubal cells was noted in a much higher percentage of specimens than was that of cells in any of the perilabyrinthine areas.

Because of their direct proximity to the tube, simple peritubal cells which do not extend into the apex tend to drain freely and are therefore seldom the cause for complications in acute suppuration.

#### INTERPRETATION OF ROENTGENOGRAMS

Histologic studies show that there is more or less variation in the degree of pneumatization in the two sides in the majority of pneumatized pyramids. As a general rule, however, this variation is only one of degree.

Pneumatization of any area in the pyramid on one side is usually accompanied by some degree of pneumatization on the opposite side.



Exceptions are to be found in patients who have had unilateral suppuration of severe grade in early years or who have had chronic suppurative disease.

In correspondence with the anatomic observations, roentgen examination has shown that asymmetric pneumatization of normal pyramids

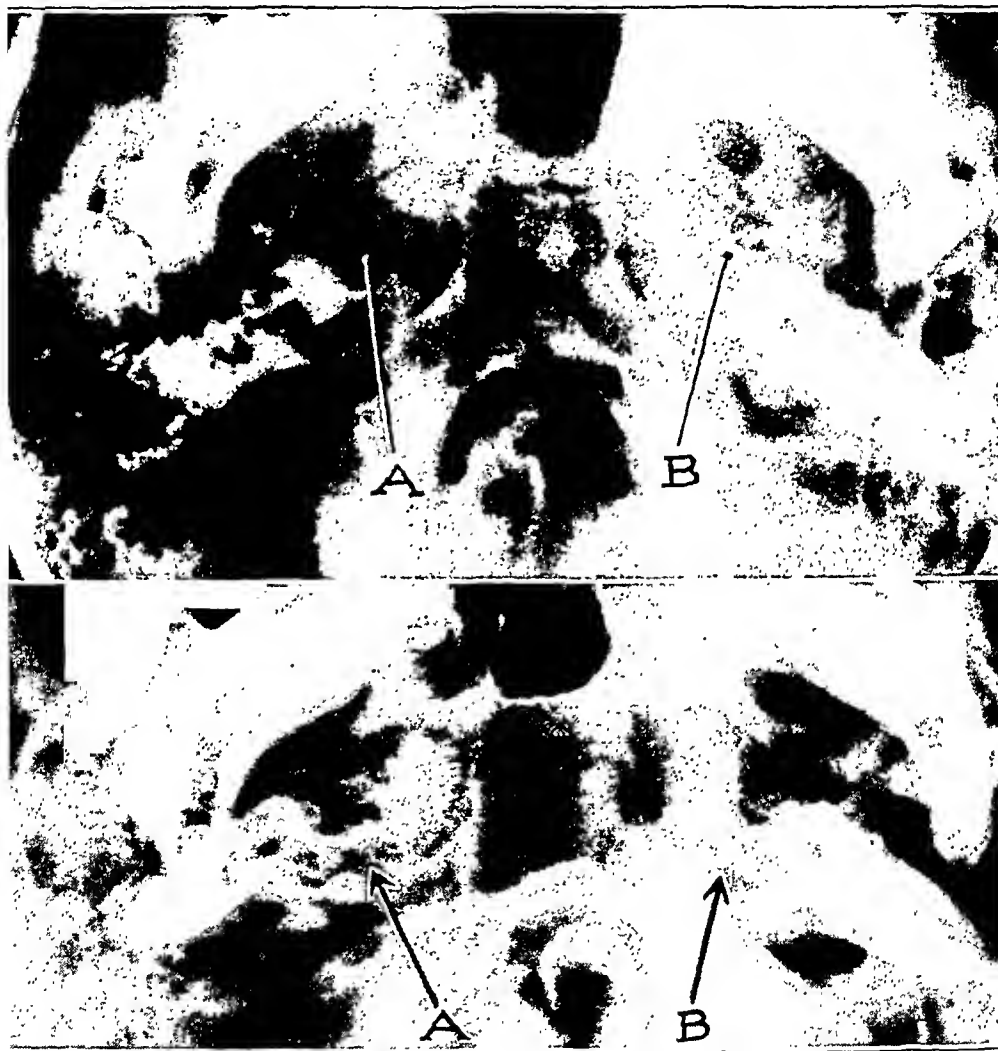


Fig. 15.—Axial view (*a*) showing pneumatization of the normal apex, *A*, while the diseased apex, *B*, shows increased density. A large closed abscess of the apex was opened by the intrapetrous approach via the middle ear. The patient recovered. In *b* the normal apex, *A*, shows clearcut cell partitions. The diseased apex, *B*, shows marked contrast, the appearance suggesting breakdown of cells. A large abscess in the apex was opened by way of the middle ear and the carotid canal. The patient recovered.

is at least frequent. In cases of chronic suppuration the interpretation of the roentgenogram may be said to have difficulties and limitations the same as or similar to those that have been found in cases of chronic mastoid disease and is not to be discussed here.

In cases of acute suppuration in the pyramid roentgen study has a fairly definite value and also definite limitations.

The information of primary importance to be obtained roentgenographically is whether pneumatization is present. The findings on the normal side are essentially important as a basis for comparison, because in the absence of chronic suppuration or previous acute suppuration, pneumatization in the normal pyramid will be accompanied by some degree of pneumatization on the opposite side.

Early suppuration causes increased density on roentgenograms, with cell outlines usually still visible (fig. 15 *a*).

Late suppuration which has caused extensive destruction of bone produces decreased density on roentgenograms, with loss of bony trabeculae. In late phases with extensive breakdown of bone the whole apex may appear as a homogeneous area with less density than on the normal side in which pneumatization can be seen (figs. 7 *a* and 14 *b*). Extensive and prolonged suppuration in an apex may invade the sphenoid bone, producing osteomyelitis and clouding of the sphenoid sinus on roentgenograms (fig. 14 *b*).

Erosion of the cortex has frequently been found, usually associated with a general decrease in density and loss of cell outlines in the area. Such erosions are seen on roentgenograms only if they involve the region of the superior angle of the pyramid (figs. 7 *a* and *b*).

In general the roentgen findings serve to confirm the impression gained from symptoms and signs and to complete the clinical picture.

In the light of present knowledge careful clinical observation almost always gives reliable evidence as to the presence of suppuration in the pyramid, but the location of the diseased area is frequently obscure, and for this purpose a careful roentgen examination may be of invaluable assistance.

The decision as to whether surgical intervention is to be undertaken for acute suppurative disease of the pyramid depends on the clinical condition as a whole. The roentgen examination furnishes an indication for surgical intervention when there is definite evidence of extension or increasing destruction of bone,<sup>5</sup> because experience has shown that diffuse meningitis may then develop rapidly, but in such instances clinical symptoms are usually present also, particularly pain, which constitutes an important danger signal.

In cases of early suppuration, when there is increased density, the roentgen findings do not constitute a surgical indication, but they give confirmatory evidence as to the location of the diseased area.

When surgical intervention is indicated the information afforded by accurate roentgen studies as to the extent and distribution of pneumatization is frequently of invaluable assistance (fig. 7).

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5. Nager, F. R.: Die Bedeutung der Roentgenuntersuchung bei den Eiterungen der Felsenbeinspitze, *Acta radiol.* **15**:475, 1934.

# EDEMA OF THE LARYNX

## A STUDY OF THE LOOSE AREOLAR TISSUES OF THE LARYNX

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Some time ago, wishing information on edema of the larynx, I was surprised to find that textbooks passed over the subject with scant attention and that the information which I wished was not readily available. I therefore decided to undertake my own investigation and have recorded the historical and experimental findings in this paper.

### HISTORY

The existence of edema of the larynx has been known and observations made on it for centuries. The first recorded account of the condition appears to be that of Hippocrates,<sup>1</sup> who described a serious and a dangerous type of angina, sudden in onset and producing marked dyspnea but showing no signs of its presence when one looked into the throat. Hajek<sup>2</sup> pointed out that it was recognized by Aretaeus<sup>3</sup> and later by Cornelius Celsus,<sup>4</sup> who both described the symptoms but could not see anything in the living patient to account for them, although they saw the condition of the throat after death. Both included the condition among the anginas.

Medical observation and activity deteriorated rather than progressed during the following years, until the advent of Thomas Sydenham on the scene. Sydenham is considered the reviver of the Hippocratic method of study, and his anatomic and pathologic observations in the latter part of the seventeenth century made it possible for Hermann

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1. Hippocrates Werke, translated from the Greek by J. F. C. Grimm, Glogau, H. Prausnitz, 1837.

2. Hajek, M., in Heymann, P.: *Handbuch der Laryngologie und Rhinologie*, Vienna, A. Hölder, 1898, vol. 1, p. 497.

3. Aretaeus Cappadox: *De causis et signis acutorum et diuturnorum morborum libri quatuor*, Oxoniae, typ. Clarendoniano, 1723, book 1, chap. 7.

4. Celsus, A. C.: *De medicina*, Florentina, Nicolao (di Lorenzo), 1478.

Boerhaave<sup>5</sup> and Gerald Van Swieten<sup>6</sup> to give the first description of edema of the larynx which was based on a sound anatomic and pathologic foundation. They described the swelling of the various parts of the larynx, with the changes in the lumen, showing how these changes could obstruct breathing and produce asphyxia. Van Swieten described the swelling as a cold, pale, watery tumor with signs of inflammation.

Late in the seventeenth century Bichat began to publish various articles on anatomy and considerable material on laryngeal edema, but his promising career was cut short by his death in 1802 at the early age of 31. In spite of his youth, he has been called the father of descriptive anatomy and was the first to give detailed descriptions of the tissues of the body in health and disease.<sup>7</sup> He appears also to have been the first to produce laryngeal edema experimentally,<sup>7a</sup> as referred to by Hajek<sup>2</sup> and Charazac.<sup>8</sup> He made incision under the tongue and pierced the epiglottis of dogs. One of the dogs died the following day from a serous angina "exactly the same as that which suffocates patients and located in the aryepiglottic folds."

It was Bayle<sup>9</sup> who first recognized the true character of edema of the larynx, realizing that it was a serous infiltration of the submucous tissues. He did not, however, recognize a noninflammatory as well as an inflammatory type of edema. Bayle, too, seemed to feel that death in such cases is due to a spasmodic condition of the lungs and not to laryngeal obstruction. Despite these errors, his studies were of great importance. His first paper with his observations was read in 1808, but its importance was not recognized until later, when his paper was published in part in 1817,<sup>9a</sup> and then more fully, in 1819, after his death.

The first to write of palpation with the finger in examining patients with laryngeal edema was Finez de Seissel,<sup>10</sup> who in 1813 published a paper on edema of this part. Even though he suggested this method of examination, he stated that he felt that it was of no use in the diagnosis in the case which he reported. Finez also appears to have been the first

5. Boerhaave, H.: *Aphorismi de cognoscendis et curandis morbis in usum doctrinae domesticæ digesti*, Frankforti ad Moenum, 1710; cited by Hajek.<sup>2</sup>

6. Van Swieten, G.: *Commentar*, in Boerhaave, H.: *Aphorismi de cognoscendis et curandis morbis*, ed. 3, Lugdum Batavorum, J. vander Linden, 1722.

7. Bichat, F. X.: (a) *Traité d'anatomie descriptive*, Paris, Gabon & Cie, 1802, vol. 2; (b) *Traité des membranes en general et de diverse membranes en particulier*, Paris, Richard, Caille & Ravier, 1799-1800, vol. 8.

8. Charazac, J.: *Etude sur l'œdème du larynx (œdème de la glotte)*, Thesis, Bordeaux, no. 33, Paris, O. Doin, 1885.

9. Bayle, G. L.: (a) in *Dictionnaire des sciences médicales*, Paris, Crapart & Panckoucke, 1817, vol. 18, p. 505; (b) *Mémoire sur l'œdème de la glotte, ou angine laryngée œdémateuse*, *Nouv. j. de méd., chir., pharm., etc.* 4:3, 1819.

10. Finez de Seissel, B.: *Quelques observations chirurgicales recueillies à l'Hotel-Dieu à Lyon*, Thesis, Paris, no. 78, 1813.

to propose the introduction of a flexible rubber tube into the larynx in such cases to prevent asphyxia.

In 1815 *Tuillier*<sup>11</sup> read his "Essay on Oedematous Angina of the Larynx" before the Faculty of Medicine in Paris, apparently knowing nothing of *Bayle's* paper, and was the first to prove by palpation with the finger the presence of the swelling in the aryepiglottic folds. The existence of this aryepiglottic swelling had been pointed out many years before by *Morgagni*.<sup>12</sup> The latter did not, however, describe any symptoms caused by the condition nor recognize the seriousness of its presence. When death occurred he considered it due to a "serous stroke" instead of to the mechanical obstruction and asphyxia caused by the swelling.

Many others wrote of edema of the larynx and various swellings in this area causing death. There were case reports of sudden asphyxia which was cured by tracheotomy,<sup>13</sup> and others reported deaths due to refusal to submit to the operation. It is reported that *Dr. Dick* advised tracheotomy for *George Washington* during his last illness but was overruled by the other physicians, who advocated bleeding instead.<sup>14</sup> Bleeding appears to have been the main treatment in those days, and as a result many died who could probably have been saved by tracheotomy. It is evident in going over the literature also that in the early days of knowledge of laryngeal obstruction little attempt was made to differentiate between obstruction developing in the larynx itself and conditions in which the obstruction was above, such as peritonsillar or retropharyngeal abscess, *Ludwig's* angina or any other infectious process developing in the area. The various types of edema were not recognized, nor was any effort made to classify them, although *Cornelius Celsus*,<sup>4</sup> who lived almost two thousand years ago, made note of an involvement of the throat with which inflammation did not appear and yet the patient could hardly breathe. Various others among the early authors mention such cases, but the difference seems not to have been recognized when it came to treatment. *Bayle* did state that "edematous laryngitic angina is either primary and essential or secondary and symptomatic," but, as *Hajek* pointed out, nowhere did he show that edema may appear independent of all inflammation or irritation.

11. *Tuillier*, M.: *Essai sur l'angine laryngée œdémateuse*, Thesis, Paris, no. 81, 1815.

12. *Morgagni*, G. B.: *De sedibus et causis morborum*, Venetiis, ex. typog., Remondiniana, 1761; cited by *Hajek*.<sup>2</sup>

13. *Ferrière*: *Sur l'angine œdémateuse*, *J. de méd., chir., pharm., etc.* **42**:248, 1784. *Vidal*: *De la bronchotomie dans l'esquinancie inflammatoire et suffocante*, *ibid.* **38**:358, 1772. *Houdry*: *Sur une angine œdémateuse prête à suffoquer le malade*, *ibid.* **41**:483, 1784.

14. *Valentin*, L.: *Recherches historiques et pratiques sur le croup*, Paris, Le Normant, 1812.

After the middle of the nineteenth century observations of the "apparently" noninflammatory edema became more frequent, and numbers of papers were published regarding this type, although none admitted the total absence of inflammation. Bouillard<sup>15</sup> said:

I did not assume that the edema of the glottis, like all other dropsies, could not result from hypercriny [sic] or from an obstacle to venous circulation. It is only sure that edemas of this nature are little known and that Bayle himself, whom nobody can accuse of having seen everywhere nothing but inflammation and irritation, has spoken of edema of the glottis as a consequence of acute or chronic inflammation of the larynx.

Rayer<sup>16</sup> admitted that a purely serous exudate might take place in the loose cellular tissues of the larynx in certain dropsies after involvement of the heart or lungs but stated that he had never seen one. Andral<sup>17</sup> said: "This disease can only be the result of inflammation of the larynx, but, let us add, we must face the fact of its existence without it."

So it goes through many papers, with none of the authors getting to the facts and all convinced that there is always an inflammatory background whether it can be found or not. The literature abounds in case reports with the cause of the edema ascribed to various infections localized at points adjacent to the larynx. Practically all the acute infectious diseases, such as "laryngeal erysipelas," syphilis, tuberculosis and diphtheria, and diseases due to administration of iodides, inhalation of steam and trauma from foreign bodies were mentioned, but it was not until after Quinke's description of angioneurotic edema in 1882<sup>18</sup> that Strübling<sup>19</sup> described "angioneurotic edema of the throat" and opened the way for a more complete understanding of the condition. Since then the possible occurrence of the condition without any pre-existing inflammation has been generally recognized.

Probably the most important item in causing the delay in the proper understanding in many cases was the inaccessibility of the area to examination. It was not until the use of the laryngeal mirror was popularized that physicians were able to examine their patients properly. Efforts were made at various times during several centuries to devise instruments for this purpose, but none seem to have gained favor until the middle of the nineteenth century, and it is only from that time

15. Bouillard, J. B.: Oedeme de la glotte, in *Dictionnaire de médecine et de chirurgie pratiques*, Paris, Gabon [and others], 1834, vol. 12, pp. 112-121.

16. Rayer, P., in *Dictionnaire de médecine et de chirurgie pratiques*, Paris, Gabon [and others], 1836, vol. 15, p. 241.

17. Andral, G.: *Cours de pathologie interne*, Leçons de path. int. 1:304, 1836.

18. Quinke, H.: Ueber akutes umschriebenes Hautödem, *Monatsh. f. prakt. Dermat.* 1:129, 1882.

19. Strübling, P.: Ueber angioneurotisches Larynxödem, *Monatschr. f. Ohrenh.* 20:314 and 376, 1886.

forward that the study of the larynx has been on a sound basis. According to Garrison<sup>20</sup> in his "History of Medicine," the dentist's oral mirror was mentioned almost two thousand years ago by Celsus, who called it a "specillum." During the seventh century Paul of Aegina devised his "glossotochus" for examining the mouth and pharynx. According to Elsberg<sup>21</sup> in his excellent review of the history of these instruments, various physicians, including Ambrose Paré, reported similar devices, none of which gained favor. In 1807 Bozzini<sup>22</sup> wrote of his "light conductor," in which he used the idea of illumination and reflection of light. In 1829 Babington<sup>23</sup> showed his "glottiscope" to the Hunterian Society of London, and it is said that he developed this instrument without any knowledge of the previous efforts of others.<sup>24</sup> It was not until after the middle of the century that any real progress was made. In 1855 Manuel Garcia,<sup>25</sup> a Spanish singing teacher living in London, reported his method of studying the larynx with mirrors. He used these to study the movements of his own larynx, as well as to study those movements in others. This method was popularized by Czermak<sup>26</sup> and Türck,<sup>27</sup> who both published their papers in 1858, Czermak on March 27 and Türck on June 26. From this time on the use of mirror laryngoscopy spread, and it is from this time that the more complete knowledge of the larynx dates.

#### PHYSIOLOGIC NATURE OF EDEMA

Hajek<sup>2</sup> seems to have been the first observer to call attention to the distinct difference in the material which infiltrates the tissues in edema, describing observations at autopsy: In certain cases clear fluid readily flowed out of the tissues after simple incision and gentle

20. Garrison, F. H.: History of Medicine, Philadelphia, W. B. Saunders Company, 1924.

21. Elsberg, L.: Meaning and History of Laryngoscopy and Kindred Methods of Examination, Philadelphia M. Times **4**:129, 1873.

22. Bozzini, P.: Der Lichtleiter oder Beschreibung einer einfachen Vorrichtung und ihrer Anwendung zur Erleuchtung innerer Höhlen und Zwischenräume des lebenden animalischen Körpers, Weimar, 1807; cited by Windsor.<sup>24</sup>

23. Babington, B.: Glottiscope, London M. Gaz. **3**:555, 1829.

24. Windsor, T.: On the Discovery of the Laryngoscope, Brit. & For. Med.-Chir. Rev. **31**:209 (Jan.-April) 1863.

25. Garcia, M.: Observations on the Human Voice, Proc. Roy. Soc., London **7**:399, 1854-1855.

26. Czermak, J.: Ueber den Kehlkopfspiegel, Wien. med. Wchnschr. **8**:196, 1858.

27. Türck, L.: Der Kehlkopfrachenspiegel und die Methode seines Gebrauches, Ztschr. d. k.-k. Gesellsch. d. Aerzte zu Wien **14**:401, 1858; Ueber Gewinnung Kehlkopf Spiegelbilder und über einige Kunstgriffe bei der laryngoscopischen Untersuchung, *ibid.* **15**:817, 1859.

pressure; in others a seropurulent or purulent exudate appeared, which was more gelatinous. Hajek also recognized that there was an inflammatory as well as a noninflammatory type of edema, that it occurred in various infectious processes about the throat or sometimes at a distance and that it occurred with renal, cardiac and pulmonary conditions.

The fact that laryngeal obstruction in some cases could be relieved by scarification and in others could not brought about the realization that the cause of this lies in the variation in the character of the fluid in the tissues, a matter of coagulability of the fluid which depends on the concentration of protein in the fluid. In spite of considerable work having been done, comparatively little is known of the tissue fluids. According to the theory of Starling,<sup>28</sup> the fluid which enters the tissues under normal conditions is practically protein free. Inquiry, vasodilation, inflammatory reactions and various other conditions may alter the capillary permeability to such an extent that, in addition to serum proteins, even blood cells may escape into the tissues.<sup>29</sup>

According to Peters and Van Slyke,<sup>30</sup> even less is known about the nature of the proteins in the tissue fluids than about their concentration. Concerning the site of origin of the plasma proteins, they state<sup>31</sup> that evidence is not available except for fibrinogen, which has been shown to be formed in the liver.<sup>32</sup> The possibility that this knowledge might have clinical bearing on the treatment has been investigated, and Full<sup>33</sup> and McLester,<sup>34</sup> among others, expressed themselves as somewhat encouraged, although their investigations seem inconclusive. Foster and Whipple<sup>32a</sup> showed that destructive and inflammatory lesions of any kind are the normal cause of increase in

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28. Starling, E. H.: On the Absorption of Fluids from Connective Tissue Spaces, *J. Physiol.* **19**:312, 1895-1896.

29. Krogh, A.: *The Anatomy and Physiology of the Capillaries*, New Haven, Conn., Yale University Press, 1922.

30. Peters, J. P., and Van Slyke, D. D.: *Quantitative Clinical Chemistry*, Baltimore, Williams & Wilkins Company, 1932, vol. 1, p. 697.

31. Peters and Van Slyke,<sup>30</sup> p. 396.

32. (a) Foster, D. P., and Whipple, G. H.: Fibrin Values Influenced by Cell Injury, Inflammation, Intoxication, Liver Injury and Eck Fistula: Notes Concerning the Origin of Fibrinogen in the Body, *Am. J. Physiol.* **58**:407, 1922. (b) Whipple, G. H., and Hurwitz, S. H.: Fibrinogen of the Blood as Influenced by Liver Necrosis of Chloroform Poisoning, *J. Exper. Med.* **13**:136, 1911. (c) McMaster, P. D., and Drury, D. R.: The Source of Fibrinogen, *Proc. Soc. Exper. Biol. & Med.* **26**:490, 1929.

33. Full, H.: Bestimmung des Fibrinogengehalte des Blutes als Leberfunktionsprüfung, *Verhandl. d. deutsch. Kong. f. inn. Med.* **33**:478, 1921.

34. McLester, J. S.: Diagnostic Value of Blood Fibrin Determinations, with Special Reference to Diseases of the Liver, *J. A. M. A.* **79**:17 (July 1) 1922.



the formation of the fibrinogen by the liver and that even in the presence of severe hepatic damage the level of fibrinogen may be increased in response to injury. The effect of hepatic destruction on the production of fibrinogen, then, is noted only in cases in which the damage to the liver has become so severe that it can no longer produce what is necessary.

Inflammatory edema is largely a vascular phenomenon, which seems primarily due to the stimulus of substances liberated from dead or injured tissues.<sup>35</sup> Great dilatation of the arterioles and capillaries occurs, probably due to paralysis by toxins which have been formed. Many capillaries which have been closed open because of loss of tone, and the permeability of their walls increases, allowing clear fluid to escape into the tissues. As more fluid is lost from the capillaries, the red cells begin to form clumps, and the slowing of the blood stream is increased; the leukocytes become adherent to the capillary walls and make their way through into the tissues, where they, together with antibodies which have been poured out with the plasma, attack and liquefy the bacteria. Schade and his associates<sup>36</sup> have shown that material from abscesses, even if the cells are removed by a centrifuge, may contain as much protein as serum or more. It is presumed that in the case of abscesses, however, a large part of the protein is derived from broken-down tissue and only a part from the blood stream.

Fluids from patients with cardiac or renal edema do not clot, and this is evidence that they contain no appreciable amount of fibrinogen. Indeed, it has been shown by Salvesen and Linder<sup>37</sup> that there was only 0.05 to 0.35 per cent total protein in the fluid from the edema in 1 case of nephrosis and 3 of cardiac decompensation. Fahr and Swanson<sup>38</sup> found only traces of globulin in such fluids. In angioneurotic edema, on the other hand, Govaerts<sup>39</sup> found the fluid to contain larger amounts of protein, the globulin content being almost as high as in the patient's plasma. He was able, also, to detect traces of fibrinogen. He inferred from this that angioneurotic edema is associated with dis-

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35. Wright, S.: *Applied Physiology*, London, Oxford University Press, 1934, p. 268.

36. Schade, H., and others: *Weitere Untersuchungen zur Molekularpathologie der Entzündung: Die Exsudate*, *Ztschr. f. d. ges. exper. Med.* **49**:334, 1926.

37. Salvesen, H. A., and Linder, G. C.: *Observations on the Inorganic Bases and Phosphates in Relation to the Protein Content of the Blood and Other Body Fluids in Bright's Disease and Heart Failure*, *J. Biol. Chem.* **58**:617, 1923.

38. Fahr, G., and Swanson, W. W.: *The Effect of Osmotic Pressure of the Plasma Proteins*, *Am. J. Physiol.* **76**:201, 1926; *Quantities of Serum Albumen, Globulin and Fibrinogen in Blood Plasma in Acute and Chronic Nephropathies*, *Arch. Int. Med.* **38**:510 (Oct.) 1926.

39. Govaerts, P.: *Etude de la composition du liquide d'œdème dans un cas "d'œdème de Quincke"*, *Compt. rend. Soc. de biol.* **99**:339, 1928.

turbances, probably vasodilator, which render the capillary walls more permeable.

Such evidence as is available, then [according to Peters and Van Slyke,<sup>30</sup> concerning the protein content of tissue fluids in disease], tends to support the theory of Starling and favors the hypothesis that renal and cardiac oedemas are not due to any change in the permeability of the capillaries.

The deficit following either proteinuria or malnutrition falls, as a rule, chiefly on the albumin factor and is accompanied by a tendency to edema. The edema of degenerative Bright's disease appears certainly, and the edema of the various malnutritional states, probably, to be due to an albumin defect in the blood plasma.<sup>40</sup>

In attempting to determine the cause of the sudden edema in cases of allergy, considerable work has been done with paraphenyldiamine, which has the same action as histamine on the capillaries but not so severe. Dubois and Vignon<sup>41</sup> were the first to point out that after its injection into dogs edema of the head and neck developed, with, sometimes, an exophthalmos. Tainter and Hanzlik,<sup>42</sup> Gibbs<sup>43</sup> and Nemours<sup>44</sup> also have worked with the drug, using rabbits and cats. The effect was similar, the vessels of the head being decidedly more involved. The larynx became markedly edematous, and the animals died of asphyxia unless tracheotomy was performed, the latter prolonging life for some time. The edematous areas when incised did not collapse, and the appearance was likened by Gibbs to that of an incised nasal polyp. Gibbs showed that the increased permeability was not due to any action of the central nervous system and was independent of it, as the same effect was observed in decerebrate animals. Electrical stimulation of the superior cervical ganglion delayed the development of the edema on the stimulated side, probably by lessening the concentration of the drug. Tainter and Hanzlik confirmed this observation and also showed that vasodilator drugs hasten the effect and vasoconstrictor drugs delay it. Ligation of the carotid arteries before injection prevents the drug from reaching the head and edema does not develop. Nemours confirmed the findings of the others and also demonstrated the presence of eosinophilic cells in the edematous tissue. These were

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40. Krogh,<sup>29</sup> p. 696.

41. Dubois, R., and Vignon, L.: Etude préliminaire de l'action physiologique de la para- et de la metaphénylene diamine, *Arch. de physiol. norm. et path.* **2**:255, 1888.

42. Tainter, M. L., and Hanzlik, P. J.: The Mechanism of Edema Production by Paraphenylene Diamine, *J. Pharmacol. & Exper. Therap.* **24**:179, 1925.

43. Gibbs, O. S.: The Edema of Para-Phenylene Diamine, *J. Pharmacol. & Exper. Therap.* **20**:221, 1923; The Relation of the Edema of Para-Phenylene to General Edema, *ibid.* **40**:65, 1931.

44. Nemours, P. R.: Experimental Edema of the Larynx Produced by Paraphenylene Diamine, *Ann. Otol., Rhin. & Laryng.* **41**:857, 1932.

not present in the control specimens, and their presence increased the similarity of the picture to that of allergy.

It has been frequently noted that certain nonantigenic substances, such as acetylsalicylic acid, in some cases produce sudden laryngeal edema. Landsteiner and Van der Scheer<sup>45</sup> in their work seem to have answered the question how this can occur. They found that a crystalloid united with a protein carrier acts as an antigenic agent, that crystalloids in conjunction with protein injected into experimental animals cause the formation of an antiserum combining anticrystalline and antiprotein functions.

#### SYMPTOMS

The onset of symptoms of laryngeal edema may be abrupt and without preliminary signs of any sort, and the symptoms may assume alarming proportions in a few minutes. In other cases some warning may be given through the presence of local factors which, to the laryngologist, suggest that the symptoms should be watched for.

Hoarseness may or may not be present. Cough is usually present but of varying severity. There are local sensations of dryness, heat and tickling. As obstruction increases there is wheezing; the breathing becomes stridorous, and asphyxia develops unless active measures are taken. There may also be difficulty and pain on swallowing, and the pain may be referred to the ear. As breathing becomes severe there is indrawing of the suprasternal notch and the abdominal muscles due to the excessive effort to pull in sufficient air. These symptoms may accompany laryngeal edema of whatever origin, but if the case is one of angioneurotic edema there may be also gastrointestinal symptoms, vomiting, abdominal pain and diarrhea. Occasionally urethral and vesical irritation appears. If the case is one in which the primary cause was an inflammatory condition about the throat, the symptoms of this condition also will be present. Cardiorenal and pulmonary diseases, of course, give their symptoms in the conditions arising from them.

With inflammatory conditions the onset is usually more gradual than with angioneurotic, and the possibility of the occurrence of edema should be borne in mind in the care of allergic patients.

Examination of the throat with edema of inflammatory origin may reveal any one of the conditions which may be the exciting cause. In some cases, because of the accompanying condition, it is almost or quite impossible to make a proper laryngeal examination because of limitation of movement of the jaw or swelling of various parts of the pharynx or tongue. However, when it is possible to insert a mirror or laryngoscope the picture depends on the part of the laryngeal

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45. Landsteiner, K., and Van der Scheer, J.: On Specificity of Serological Reactions with Simple Chemical Compounds (Inhibition Reactions), *J. Exper. Med.* **54**:295-305, 1931.

structure involved. The epiglottis is much swollen, and the space between it and the base of the tongue may be completely filled with a swollen and glistening mass. One or both of the aryepiglottic folds may be greatly swollen, and these may become so large that they can be seen projecting as rounded smooth masses above the base of the tongue as soon as the latter is depressed. The space between these folds may be so narrowed that further examination is impossible. If the edema is inflammatory in origin the swellings are pinker; if it is angioneurotic they are paler and have more the appearance of a glistening nasal polyp. In the latter event, too, they have a firmer appearance than edema of inflammatory or cardiorenal origin.

#### CAUSATION

The causes of edema of the larynx may be outlined as follows:

##### I. Local causes

###### A. Noninfectious conditions

###### (a) In the larynx

1. Irritation by a foreign body
2. Fracture, wounds of larynx or injuries at birth
3. Inhalation of steam
4. Inhalation of irritating gases
5. Contact with corrosive liquids
6. Contraction of scar tissue following operation

###### (b) In tissues adjacent to the larynx

1. Wounds or foreign bodies involving the base of the tongue or the pharynx
2. Neoplasms or scars in adjacent tissues causing interference with venous return
3. Enlargement of the thyroid
4. Exposure to roentgen rays or radium

###### B. Infectious conditions

###### (a) In the larynx

1. Ulceration from tuberculosis, syphilis, chronic laryngitis, typhoid fever, smallpox or gonorrhea (rarely)

###### (b) In tissues adjacent to the larynx

1. Pharyngeal involvement of acute infectious diseases
2. Tonsillitis and peritonsillar abscess
3. Pharyngitis and retropharyngeal abscess
4. Lingual tonsillitis
5. Cervical adenitis
6. Ludwig's angina
7. Erysipelas
8. Cellulitis of the neck

##### II. General causes

- A. Allergy
- B. Cardiac disease
- C. Renal disease
- D. Pulmonary disease
- E. Medication (iodides)

## TREATMENT

The treatment of laryngeal edema depends in part on the condition underlying the local involvement, although in all cases, irrespective of causation, the basic consideration is to open and keep open the airway. In general the patient should be in bed in a room with moist air. (A steam kettle with tincture of benzoin compound is useful.) Vocal rest and absolutely quiet surroundings are important. If the patient can swallow and is not too debilitated, catharsis is indicated and hot packs may be used.

Local spraying with epinephrine, 1:100, chilled, or even a weaker solution may be of great aid in reducing the swelling. Naturally, attention to any local condition in the throat which might be the primary cause is called for. Scarification of the edematous areas is of little use except in conditions of cardiac or renal origin in which the fluid in the tissues does not coagulate. In most of the other cases scarification may only tend to increase the inflammation and give little if any relief. Cold compresses may be helpful, and cracked ice in the mouth may give relief. No matter what the origin or what other measures are taken, when the condition is severe the physician should be prepared to do emergency tracheotomy. Inhalation of oxygen may carry the patient over a critical point. The patient's strength should be sustained by whatever measures seem most suitable.

In cases of angioneurotic edema hypodermic administration of epinephrine, 1:1000, in 0.5 or 1 cc. doses will in most cases give rapid relief. Local spraying with chilled epinephrine, 1:100, as mentioned, is helpful. Scarification and application of medication by means of swabs is unwise. Absolute silence should be enforced, the patient not being allowed to utter a word. The patient should be constantly watched and facilities always at hand for quick tracheotomy. In most cases the condition will spontaneously subside, and as soon as possible after this tests should be made to determine the exciting agent. Jackson <sup>46</sup> stated that sometimes the signs seen in the laryngeal mirror are a better index to the condition than is the dermal reaction to the test. Focal infections should be looked for in the nose and throat, but unless indications are definite, operation should not be rushed. All observers seem to point out the great need for a complete history, going thoroughly into the patient's habits and environments. In so far as possible all sources of, or causes for, worry should be removed, as it appears that worry and mental stress are definite factors in the precipitation of some attacks. Jackson advocated a thorough general

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46. Jackson, C., in Jackson, C., and Coates, G. M.: *The Nose, Throat and Ear and Their Diseases*, Philadelphia, W. B. Saunders Company, 1929, p. 836.

examination, even with endocrine investigation, but stated the belief that whatever endocrine imbalance appears is not a causative factor but a result of faulty habits of life which have been involved in the condition and that the imbalance will clear up after the patient is put on a proper regimen.

Family history should be looked into. Heredity is an important factor, Osler<sup>47</sup> having reported angioneurotic edema in 19 of a family of 39 in five generations, at least 2 of whom died of the condition. J. R. and T. R. Crowder<sup>48</sup> reported 27 among 63 persons in five generations, half of whom died of the condition.

It is well to caution against the indiscriminate use of antitoxins or the administration of serums of any kind to persons who are known to be allergic or who have a family history of allergy and always to be cautious with patients to whom a serum has been administered previously. If it is essential that a serum be given, desensitizing doses should be injected and a careful watch kept during the process.

It might be well also to call attention again to the need for facilities for performing tracheotomy in all serious attacks.

Certain angioneurotic patients die suddenly, and it has been suggested by Theisen<sup>49</sup> that some of these deaths may be due to edema involving the cardiac or respiratory center in the brain.

#### EXPERIMENTAL WORK

The principal experimental work on the loose areolar tissues of the larynx in an endeavor to find the limits to which edema might extend has been done by Sestier,<sup>50</sup> Hajek<sup>2</sup> and Logan Turner.<sup>51</sup> The first experimental work was reported by Bichat<sup>7a</sup> when he produced edema in the epiglottis of a dog, as mentioned earlier in this paper. This, however, gave little information as to the extent to which the edema might spread. Sestier first attempted to determine the situation by seeing where the mucosa would strip off readily. He later performed his classic experiment, in which he ligated the left carotid artery in a cadaver and injected about 2 quarts (1.9 liters) of water into the right. Hajek in his work injected directly into the submucous tissues,

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47. Osler, W.: Hereditary Angioneurotic Edema, *Am. J. M. Sc.* **95**:362, 1888.

48. Crowder, J. R., and Crowder, T. R.: Five Generations of Angioneurotic Edema, *Arch. Int. Med.* **20**:840 (Dec.) 1917.

49. Theisen, C. F.: Acute Laryngeal Edema, *Ann. Otol., Rhin. & Laryng.* **33**: 487, 1924.

50. Sestier, F.: *Traité de l'angine laryngée œdémateuse*, Paris, J. B. Baillière, 1852.

51. Turner, A. L.: The Submucous Areolar Tissue of the Larynx and Its Significance in the Spread of Edema, *Edinburgh M. J.* **11**:417, 1902.

as did Logan Turner. The present work confirms, in the main, their findings, but certain conflicts will be pointed out.

This work was done through the courtesy of Dr. Oscar Batson and the department of anatomy of the Graduate School of Medicine of the University of Pennsylvania.

The specimens consisted of 15 infant and 4 adult larynxes. A block removal was made of the tissues of the neck anterior to the vertebral muscles, so that each specimen consisted of the tongue, the soft palate, the entire pharynx, the larynx, the trachea down to about the fourth or fifth ring and upper part of the esophagus. Adult specimens were all recent, and infant specimens were from newborn babies,

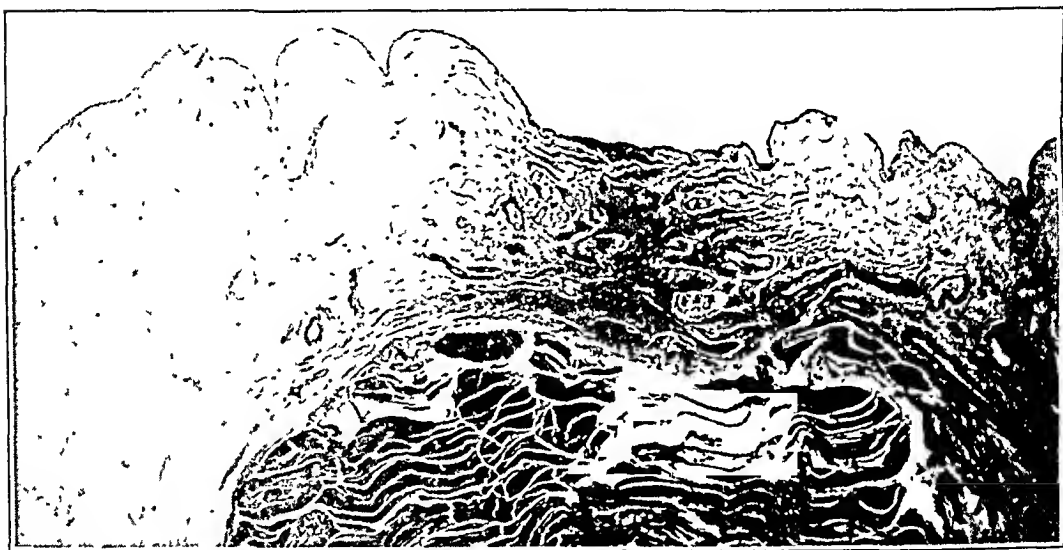


Fig. 1.—Section of tissue from over the cricoid of an infant, showing the dense fibrous barrier in the midline. This specimen was injected from one site on the left side, and the fluid was held up by this barrier until, on further injection it passed around in front of the epiglottis and traveled backward to meet the cricoid barrier on the right side. (Kaiserling's solution was injected.)

the majority of which had been frozen. The frozen specimens were thawed slowly, and none of the series was heated at any time. Some of the injections were made with Kaiserling's solution no. 3, a mixture of potassium acetate, glycerin and water. Others were made with a 10 per cent solution of gelatin colored with water blue. The specimens were split up the midline of the posterior pharyngeal wall, and injections were made directly into the submucosa.

In the infants the injections were in most cases made under the mucosa of the pharyngeal wall and the entire injection carried out through this one site. A flattened swelling at once appeared and extended forward to the lateral pharyngoepiglottic fold, where it was

temporarily held in check, the fluid meanwhile almost obliterating the piriform sinus. At the same time, the aryepiglottic fold became edematous to a marked degree, and the fluid found its way downward through the submucous tissues over the esophageal aspect of the cricoid, but the spread here was abruptly checked in the midline. The swelling extended downward for a short distance below the lower margin of the cricoid and was almost baglike in appearance.

The presence of this barrier of fibrous tissue in the midline over the cricoid seems to be described here for the first time. Neither Hajek



Fig. 2.—Infant larynx injected through the left side with Kaiserling's solution, showing the median barrier over the cricoid to be sufficiently dense to hold the fluid in check, although enough force was used to force it forward around the front of the epiglottis and to involve the aryepiglottic fold of the opposite side.

nor Turner mentioned it; indeed Turner definitely stated that the fluid readily passes from one side to the other over the cricoid.

By injection of further material through the same site the whole of the lateral edematous area became more cup shaped, the fluid breaking through the lateral pharyngoepiglottic fold, where it had encountered some resistance, and passing on after a short delay at the lateral glossoepiglottic fold to enter the vallecula. During this development the fluid further expanded the aryepiglottis fold and passed up on the anterior surface of the epiglottis but stopped abruptly at the margin



of this structure. The vallecula was obliterated as the fluid was again held up by the median glossoepiglottic fold. This fold contains more fibrous tissue than the lateral folds and provides more resistance to the passage of the fluid. Even when fully injected this fold will be outlined by a depression in the midline over the edematous epiglottis. The entire anterior surface of the epiglottis becomes edematous, and the fluid passes forward on the base of the tongue almost as high as the tip of the epiglottis. This observation also seems to vary from

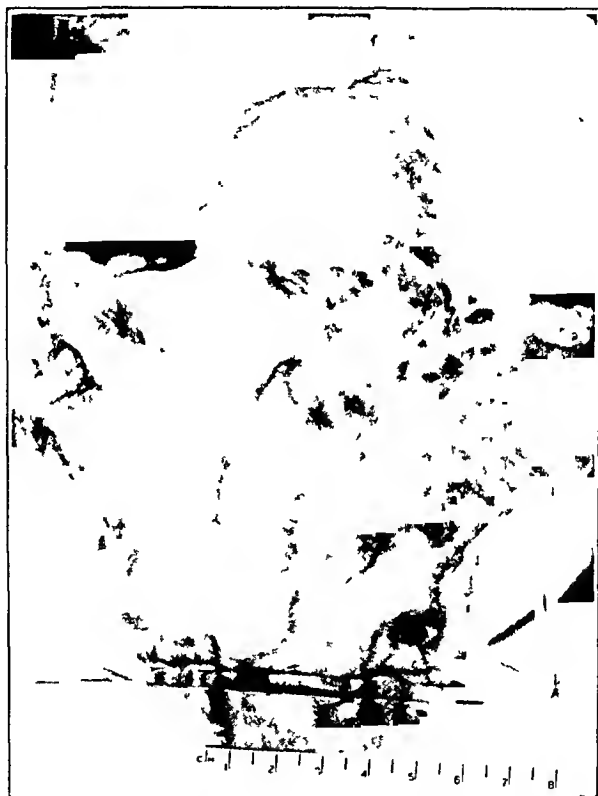


Fig. 3.—Larynx of an adult Negro injected with Kaiserling's solution; marked edema over the cricoid stopping abruptly in the midline; piriform sinus and aryepiglottic fold much involved, with beginning edema over the epiglottis. The side of the epiglottis is being bent inward by the pressure of the edema.

the findings of previous observers, as they stated that the edema would not spread farther than halfway to the level of the epiglottic tip.

As further fluid is injected, the resistance of the median glossoepiglottic fold is broken down, and the vallecula on the opposite side is obliterated by an edematous mass which spreads all over the anterior surface of the epiglottis and upward on the base of the tongue. Still further injection through the original site forces the fluid through

the submucous tissues of the opposite side, the process already described being repeated but in reverse order, until the fluid meets, traveling in annular fashion, the dense fibrous barrier in the midline over the cricoid.

As is shown in figure 4, when the injection is carried out from behind and the aryepiglottic folds involved, first there tends to be an incurvation of the lateral margins of the epiglottis, which in the infant exaggerates the natural V shape of that structure and in the adult causes it to approximate the infantile V type. On the other hand, it



Fig. 4.—Infant larynx injected with Kaiserling's solution from four points, from either side of the pharynx below and from either side anteriorly above the valleculae; exaggeration of the infantile V shape of the epiglottis; abrupt limitation of the edema at the epiglottic rim; close approximation of the aryepiglottic folds; marked edema over the esophageal aspect of the cricoid, with the median barrier outlined as a groove.

was found that if the injections were made so as only to affect the valleculae and the anterior surface of the epiglottis the latter was broadened, was less curved than normal and was not forced backward over the airway. This has already been pointed out by Turner.<sup>51</sup>

On opening the larynx it was found that the injected material failed to involve the under surface of the epiglottis at any point, because the mucosa was densely adherent. The aryepiglottic folds were completely filled, as was all the space between the laryngeal mucosa, the thyrohyoid membrane, the thyroid and the cricoid cartilage. The ven-

tricle was obliterated, and its opening into the larynx was outlined as a mere slit. There was practically no edema over the true cords, although they showed rounded edges.<sup>52</sup> There was some involvement of the submucous tissues of the ventricular bands, particularly on the upper aspect, where they are looser and more abundant. Both true cords and ventricular bands could be readily identified and were not



Fig. 5.—Adult larynx injected with gelatin colored with water blue; *A*, epiglottis; *B*, aryepiglottic fold; *C*, thyroid cartilage; *D*, ventricular band; *E*, ventricle obliterated; *F*, true cord; *G*, infiltration of underlying tissues forcing cords medially; *H*, cricoid cartilage.

lost in the edematous mass. On cross section the tissues forming these structures were shown to be practically uninvolved (fig. 5).

52. Clinically edema of the true vocal cords is rare but occasionally occurs, producing rounding of the edge or, when circumscribed, resulting in sessile or pedunculated polyps. When this occurs it is due to involvement of Reincke's space, which is "a potential microscopic space, probably consisting of a basement membrane of colloidal material lying beneath the epithelial lining of the cords and extending

Sestier, Hajek and Turner all found little submucous areolar tissue over the ventricular bands and practically none over the true cords. They all realized that obstruction occurring in this area is due to these structures being forced medially en masse by infiltration of the underlying tissues, though considerable swelling may occur on the upper aspect of the ventricular bands. Sestier found actual infiltration of fluid between the fibers of the thyroarytenoid muscle.

In none of the specimens could edema be demonstrated in the area below the true cords.

One specimen was injected before being split down the midline of the pharynx, and the fluid was found limited to the side of the pharynx injected.

These findings confirm the work of previous observers in the main, but two new facts are presented:

1. A dense and definite fibrous band holds down the mucosa along the midline over the cricoid cartilage on its esophageal surface, running in a vertical direction.

2. Submucous areolar tissue on the base of the tongue extends upward as high as the tip of the epiglottis.

#### CONCLUSIONS

While experiments on the cadaver cannot exactly reproduce what occurs in the living subject, they can undoubtedly give a rather accurate idea of the extent to which edema of the larynx may extend. They seem to indicate that edema may be localized between two adjacent condensations of fibrous tissue, represented by the barriers which have been pointed out. Certain chemical or physiologic effects of the fluids may develop in these tissues in disease which might lessen the efficiency of these condensations as barriers to the spread of involvement, as compared with their efficiency in checking the spread of the fluid in these injections. Certain types of edematous fluid may spread more rapidly than others because a difference in the protein content affects the diffusibility. Various factors such as these make it difficult to evaluate clearly the clinical importance of these particular findings. Localized edema is known, however, to occur in various parts of the larynx, and that many times in areas which might be limited by the barriers here described. So far as I have been able to determine, however, no clinician has observed unilateral edema over the esophageal surface of the cricoid. Whether this is because it has been hidden by edema over the arytenoid areas I do not know, but it

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from the anterior extremity only to the tip of the vocal process." Lederer, F. L.: *Diseases of the Ear, Nose and Throat*, Philadelphia, F. A. Davis Company, 1938, p. 568.

seems likely, as involvement of this area would almost surely be accompanied by edema over the arytenoid area and the aryepiglottic fold of that side.

These experiments indicate also that if the edema involved only the valleculae and the anterior surface of the epiglottis, there would be little interference with breathing and probably few symptoms other than a sensation of a mass in the throat. It is possible, however, that with the broadening of the surface of the epiglottis and the consequent interference with close approximation of the aryepiglottic folds there might be some difficulty in completely closing the airway when swallowing and fluids might trickle down into the larynx. Such a localization might follow involvement of the lingual tonsil or ulcerations of the epiglottis.

The results indicate, too, that with infections of the tonsil or the lateral pharyngeal wall when edema arises it may extend downward into the piriform sinus and from there extend into the aryepiglottic fold. Edema of one aryepiglottic fold might cause some respiratory difficulty but would not cause asphyxia; however, if both should become involved the situation would become acute. It appears that in mild conditions the fold only would be invaded, but it seems sure that if there were much swelling of the structure the fluid would almost certainly have to extend down over the esophageal surface of the cricoid and also invade the deeper tissues on the interior of the larynx. If this involved only one side there would still be breathing space, but if both were involved there would be asphyxia.

The findings seem to emphasize the need for careful watching in any case in which edema has developed or may develop, as the fluid may travel fast and far and when there is swelling of the upper structures one cannot see how rapidly the obstruction is developing below. One should always be prepared for emergency tracheotomy at the first signs of acute asphyxia.

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# OF WHAT VALUE IS ROENTGEN THERAPY FOR SINUSITIS?

A RHINOLOGIC STUDY OF TWENTY-TWO CASES

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Rhinologists are frequently confronted today with the question of the value of roentgen therapy for sinusitis. Are they sufficiently informed of the effects and end results of this type of therapy to give an intelligent answer?

A review of the literature indicates that little has been written on this subject by rhinologists, either in America or abroad. With few exceptions it is discussed by radiologists alone. While this may seem logical, it is, on the contrary, impracticable. One cannot omit the rhinologic phase if the end result is to be properly evaluated.

Thost<sup>1</sup> first called attention to this form of therapy, in 1913. However, little interest was shown in the United States until 1923, when Osmond<sup>2</sup> reported a series of cases in which treatment was favorable. Heidenhain and Fried<sup>3</sup> followed this report in 1924. Beginning at this time many indifferent and conflicting reports appeared in foreign literature, but it was not until 1932, when Butler and Woolley<sup>4</sup> reported 100 cases of chronic sinusitis treated with promising results, that radiologists in America developed much interest. In their enthusiastic presentation at the meeting of the American Medical Association in 1934 Butler and Woolley<sup>5</sup> discussed the follow-up results of treatment in 450 cases, naming five classifications of sinusitis, with an aggregate report as follows: entire relief in 55 per cent of cases, definite improvement in 36 per cent and no improvement in 9 per cent. Their best

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Presented as a candidate's thesis to the American Laryngological, Rhinological and Otological Society, Inc.

1. Thost, A.: Die Behandlung von Erkrankungen der oberen Luftwege und Ohren mit Roentgenstrahlen, *Monatschr. f. Ohrenh.* **48**:84-106, 1914.

2. Osmond, J. D.: Roentgen Therapy of Acute Infections of the Antrum and Frontal Sinus, *Am. J. Roentgenol.* **10**:374-377, 1923.

3. Heidenhain, L., and Fried, C.: Röntgenbestrahlung und Entzündung, *Arch. f. klin. Chir.* **133**:624-655, 1924.

4. Butler, F. E., and Woolley, I. M.: Roentgen Therapy in Chronic Sinusitis, *West. J. Surg.* **40**:379-383, 1932.

5. Butler, F. E., and Woolley, I. M.: Roentgen Therapy in Chronic Sinusitis, *J. Radiology* **28**:528-537, 1934.

results were obtained in cases of chronic sinusitis with hyperplastic membranes and their poorest results in cases of polypi. In contrast to other observers, they obtained some response from patients with an atrophic type. They stated also that in cases of chronic sinusitis with fibrotic membranes their results were variable, while in cases of post-operative sinusitis only clinical improvement appeared. Warren<sup>6</sup> reported 72 cases in which sinusitis was treated in 1935 with good results. He included all forms of sinusitis except atrophic. He classified his cases in three groups stating that virgin sinusitis of the hyperplastic type gave the best response. The results with the purulent type were less spectacular and those in cases of polypi or cysts were disappointing. Collectively, his results were as follows: marked improvement in 40 per cent of cases, moderate improvement in 25 per cent, temporary results in 20 per cent and no change in 15 per cent. He did not report any patient as cured. Hodges<sup>7</sup> preferred to treat patients that manifest thick membranes with granulations. He believed that acute infections with pus, here as in other parts of the body, should be drained. Rathbone<sup>8</sup> reported a large series of cases (72) of children only with the following conclusions: 57 per cent of the patients apparently cured, 28 per cent improved and 15 per cent not benefited. He stated that the ideal child to treat is one with diffuse lymphoid hyperplasia throughout the sinuses and throat, with a watery discharge. Soloman and Weill<sup>9</sup> were less enthusiastic, stating that their results seemed only of sufficient interest to justify calling their colleagues' attention to this new form of therapy. Koch<sup>10</sup> in an exceedingly lengthy article discussed many phases of the treatment. His series consisted of 22 cases in which the patient responded well and 28 cases of chronic sinusitis in which the patient did poorly; that is, only 11 of the 28 patients recovered. He defined recovery as meaning disappearance of pain and secretion. Whether the membrane returned to normal or not he did not know. Holfelder<sup>10a</sup> said that the results in his experience were uncertain, and he expressed opposition to irradiation of the sinuses. Spiesz and Vosz<sup>10a</sup>

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6. Warren, E. D.: The Value of X-Ray Therapy in Chronic Sinusitis, *Laryngoscope* **45**:864-876, 1935.

7. Hodges, F. M.: Roentgen Therapy of Infections of the Nasal Accessory Sinuses, *Am. J. Roentgenol.* **39**:578-584, 1938.

8. Rathbone, R. R.: Roentgen Therapy of Chronic Sinusitis in Children, *Am. J. Roentgenol.* **38**:102-108, 1937.

9. Soloman, I., and Weill, G. A.: La roentgentherapie dans le traitement des sinusites, *Oto-rhino-laryng. internat.* **16**:523-525, 1932.

10. Koch, J.: Klinische und experimentelle Erfahrungen über die Röntgenbestrahlung akuter und chronischer Nebenhöhlenerkrankungen, *Arch. f. Ohren-, Nasen- u. Kehlkopfh.* **143**:385-405, 1937.

10a. Cited by Koch.<sup>10</sup>

also were opposed to this form of therapy. Champeil and Tillier<sup>11</sup> have expressed with emphasis the definite relief of pain afforded their patients, but they were uncertain about any curative effects. Kisch and Salmond<sup>12</sup> voiced a like report on the treatment of 7 patients.

A personal check-up in 22 cases of chronic sinusitis observed before and after roentgen therapy has caused me to question whether the results generally reported in radiologic literature are not more apparent than real. It seems that this could be determined only by including clinical studies by the rhinologist and microscopic studies by the pathologist. The conclusions drawn from the study of this small group mean little statistically, yet close clinical and microscopic observation in a few cases may be of more worth than the evaluation of subjective symptoms and roentgen evidence in a much larger series. Four patients in my group showed complete relief of symptoms. The clinical findings were entirely normal and the diagnostic films clear. These patients were considered, in a sense, well. Eight patients were symptomatically improved; that is, they manifested better nasal respiration and less secretion. Follow-up films indicated moderate to complete recession of the membranes, which could be interpreted as improvement in some cases and complete relief in others. However, none of the patients were entirely normal clinically. Irrigations of the antrums of 3 of the 8 patients showed purulent discharge. Ten patients thought that they were not helped symptomatically. Scout films did not show any appreciable change from the original roentgenograms. Clinical examinations showed little or no difference from the condition before roentgen treatment. Four of the 10 patients who did not show clinical or roentgen change in their condition after treatment were operated on. Each patient was subjected to a double Caldwell-Luc operation. The antrums in each case were found to contain hyperplastic infiltration and polypoid granulations filling the cavity nearly to its capacity and accompanied by a purulent discharge. Cultures showed streptococci. Observations by direct inspection of the antral contents during operation did not vary from those on similar infections in other cases, in which the operative condition had not been subjected to irradiation. Adhesions or unusual difficulties were not encountered in removing the contents from the cavities. Healing was uneventful and results satisfactory. In other words, nothing out of the ordinary was encountered in the operative technic, healing or end results in these antrums to indicate that irradiation had affected them in any way.

11. Champeil and Tillier, R.: Radiothérapie dans les sinusites fronto-maxillaires, *Bull. et mém. Soc. de radiol. méd. de France* **19**:420-422, 1931.

12. Kisch, H., and Salmond, R. W. A.: Treatment of Post-Operative Pain in Chronic Sinusitis by X-Rays, *J. Laryng. & Otol.* **49**:464-465, 1934.



Under microscopic study, sections made in these cases did not show evidence of roentgen therapy, with the exception of that from a patient who was operated on six days after his treatment. This sec-



Fig. 1.—Photomicrographs of tissue removed from chronically inflamed antrums during Caldwell-Luc operations. Prior roentgen treatments have not left a demonstrable effect.

tion showed fewer lymphocytes than did the other slides. Otherwise, there was not any obvious difference. This is in keeping with the generally accepted opinion regarding the effect of roentgen treatment

in certain types of cases. It is possible that in the other cases a like change in the tissues was experienced, but regeneration of lymphocytes occurred during the longer interim between treatment and operation.

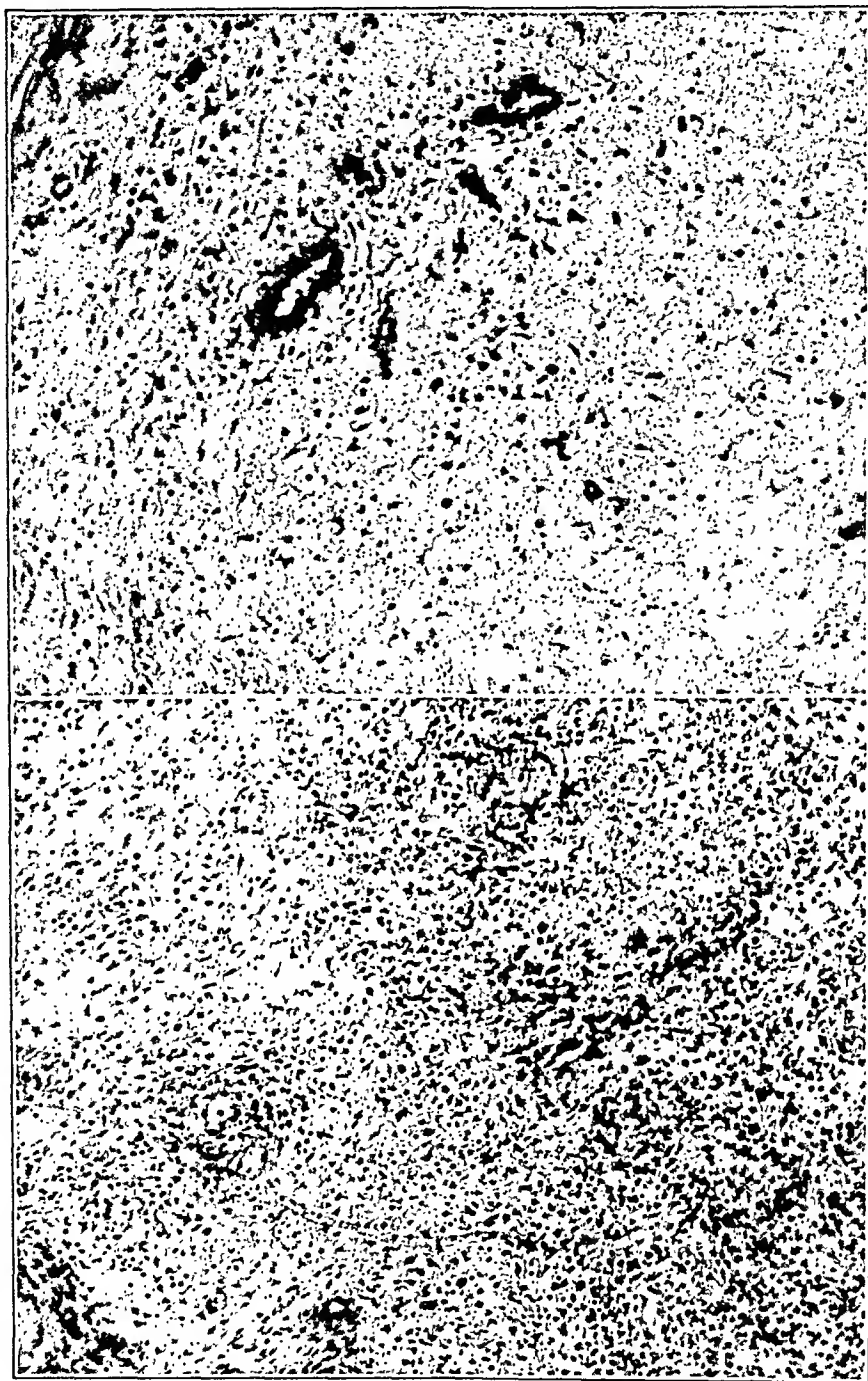


Fig. 2.—Photomicrographs made under the same conditions as those shown in figure 1, with the same results.

With this single exception all the sections showed infiltration of round cells and numerous fibroblasts with proliferation of connective tissue. Evidence of macrophages, arterial obliteration or necrotic spots was not

present. There were a few scattered areas of ciliated epithelium, but in the main this had been replaced by pathologic changes.

These 22 cases were observed before and after the radiologic treatments. My examinations consisted of the taking of histories, clinical inspection, investigation by shrinkage, suction and lavage and comparison of films taken before and after treatments. Rhinologists who interpret their own roentgenograms realize through other methods of examination how unreliable roentgen examination may be in analyzing disease of the ethmoid or the sphenoid sinus. Most of the roentgenologic literature describing films taken before and after treatments emphasizes in particular the antral changes, which are frequently marked if the sinusitis is hyperplastic. However, it is known that this is not sole proof, as parallel changes may occur spontaneously in many instances. Similarly, contrast shadows are not so easily demonstrated in the frontal sinuses, and I have never been able to note any appreciable difference in the roentgenograms of the ethmoid and sphenoid sinuses before and after treatment. Case reports that appear in the radiologic literature seem not to include any uniform rhinologic study whatsoever. If proper evaluation is to be made of this form of therapy the investigation should be shared by those versed in the clinical and microscopic aspects of this disease. Radiologic examinations alone are incapable of leading to such an evaluation. I make this statement in full recognition of the valuable part which roentgen examination plays in the diagnosis of sinusitis, as it has been my custom for the past fifteen years to make office routine of this procedure. In this connection Fenton<sup>13</sup> made the following statement:

. . . reliance upon radiographic "diagnosis" must be confirmed by the clinician. It should be remembered that malignancy, syphilitic infiltration and long-standing fibrous changes may look just as opaque in a radiograph as do the edematous lining or the mucopurulent exudate of ordinary sinus diseases.

It is generally agreed by all radiologists and accepted by rhinologists that roentgen rays affect certain hyperplastic types of sinasal membrane. In other types, there may be a temporary recession of lymphoid tissue with regenerative changes. Other membranes may present more established fibrosis, which resists irradiation from the outset. Without exception all roentgentherapeutists agree that their most favorable results are with sinusitis presenting marked infiltration with little air space and that thought to be subacute or of recent development. This is probably why young children, in general, are thought to be more responsive than adults. It is common knowledge that roentgen rays do not inhibit bacterial growth directly, yet this fact does not preclude

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13. Fenton, R. A.: Recent Trends in Treatment of Sinus Disease, *Northwest Med.* **33**:90-95, 1934.

the rays from acting as an adjunct indirectly by promoting better drainage and ventilation in certain hypertrophic types. Fenton expressed the opinion that sinusal membranes which present a preponderant lymphocytic infiltration may receive some benefit from this form of treatment. Larsell and Fenton<sup>14</sup> stated in another article that the therapeutic use of roentgen rays may produce some fibrosis following the destruction of round cells but that healing of suppurative changes in the submucosa cannot thus take place.

According to Larsell, as quoted by Butler and Woolley:<sup>6</sup>

The effect of the x-ray treatment appears to be due primarily to an early destruction of the lymphocytes in the infected membranes. About 48 to 72 hours after treatment of membranes which had been infected for several weeks, there appears to be an increase in the number of macrophages. These are believed to come in response to substances released by the breaking down of the lymphocytes. These macrophages are seen to be laden with cellular debris and blood pigments. It is possible that they also engulf bacteria.

The membrane becomes gradually reduced in thickness but retains numerous plasma cells, polymorphs, and some histocytes. After a week or more some fibrosis appears. Several weeks after irradiation, nodule-like masses of lymphocytes may be seen in some of the membranes, indicating a return of lymphocyte formation.

There is no evidence of injury to the cilia, epithelium, or cellular elements other than the lymphocytes as the result of x-ray dosage. The fibrosis is considered a result of the inflammatory process, and the increased number of histocytes immediately following the infection.

Heine,<sup>15</sup> writing on the effects of irradiation on ciliated epithelium, corroborated these statements in effect. From the clinicians' point of view acutely inflamed sinuses should not be subjected to irradiation. This is especially true in cases in which ample drainage facilities may not be provided, on account of the acute swelling that may follow such a procedure.

A standardized technic does not appear to be used by radiologists as a whole for this form of therapy, judging from the literature. Many of the authors favor large infrequent doses, and others prefer light doses scattered over a longer period. The importance of proper technic in order to avoid undesirable effects on the eyes, the sense of smell and the hypophysis is stressed by all radiologists.

It is well recognized, with all the precautions considered, that it is impossible to irradiate all the sinuses without including the pituitary gland. Knowing that glandular structure is peculiarly sensitive to

14. Larsell, O., and Fenton, R. A.: Further Research on Experimental and Clinical Sinusitis, *Arch. Otolaryng.* 20:782-789 (Dec.) 1934.

15. Heine, L. H.: Effects of Radiation upon Ciliated Epithelium, *Ann. Otol., Rhin. & Laryng.* 45:60-74, 1936.

roentgen rays, one should proceed cautiously in applying this therapy to the young. It is my suggestion that animal experimentation with similar technic should be thoroughly exploited before this form of therapy is accepted as harmless.

#### CONCLUSIONS AND SUMMARY

It seems that roentgen therapy for any form of sinusitis is in its earliest experimental stage.

Closer cooperation between the radiologist, the rhinologist and the microscopist must be obtained before determining the true effects of this therapy.

It is essential that the rhinologist make the final examination in order to avoid erroneous conclusions in many instances.

Twenty-two patients were examined roentgenologically and rhinologically before and after receiving therapy, with no definite evidence of uniform improvement of the infection in spite of roentgenologic changes.

With the exception of a single case, microscopic examination of the polypoid content of 8 antrums which had been subjected to roentgen therapy did not show any obvious difference from similar pathologic contents of other antrums which had not received like treatment.

Drs. William A. Shepherd and George Z. Williams interpreted the microscopic slides.

# USE OF EXPANDING ESOPHAGOSCOPE FOR EXTRACTION OF FOREIGN BODIES

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The extraction of a foreign body is often most difficult, and in some cases the usual instruments prove unequal to the task. This being so, the use of certain new instruments is a great help, among which is the expanding esophagoscope which I have designed.<sup>1</sup>

The great difficulty met in using some instruments is due to the tendency of the wall of the esophagus to contract and to press the ends of the tubes together. In designing my instrument, I aimed to remove this disadvantage.<sup>2</sup>

The expanding esophagoscope consists of a special extension mechanism, permitting adjustment of the grooved halves of the speculum in relation to each other as desired and helping to resist the considerable pressure of the esophagus, and various interchangeable grooved speculums differing in size and shape, viz., round, rectangular, square and oval.

In its closed position, thanks to its slenderness, the instrument can be easily introduced (fig. 1), after which it can be adjusted to the desired width and the distance between the halves of the speculum set as required. The mechanism provides for a great expansion between the halves of the speculum.

The uses to which the expanding esophagoscope can be put are various. My experience has shown that it is useful for the extraction of large foreign bodies. Once introduced, the esophagoscope can be expanded to the necessary width, and the foreign body can be seized and withdrawn without causing any wound in the wall of the esophagus.

Two cases are cited here as examples:

CASE 1.—A woman aged 46 when eating soup felt something lodge in her throat and was unable either to eat or to drink anything. Living far away in the country, where a physician was not available, she did not make an immediate attempt to secure medical aid, and it was only on the third day that she visited a physician in a neighboring town. From him she was sent to me, arriving on the fourth day.

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1. Matis, E. I.: Der erste Schritt zur Konstruktion eines parallel spreizbaren Broncho-Oesophagoskopes, *Monatschr. f. Ohrenh.* **70**:929, 1936.

2. Matis, E. I.: Was wird mit der Konstruktion des spreizbaren Broncho-Oesophagoskopes bezweckt? *Acta oto-laryng.* **25**:61, 1937.

The patient was a stout woman with a short neck. She complained of pain in the side of her neck when it was touched. There was also some swelling at that point. She had a slight fever and was unable to swallow at all.

*Operation.*—Local anesthesia of the pharynx was induced with a 2 per cent solution of pantocaine hydrochloride. The patient was seated, in the position recommended by Killian.

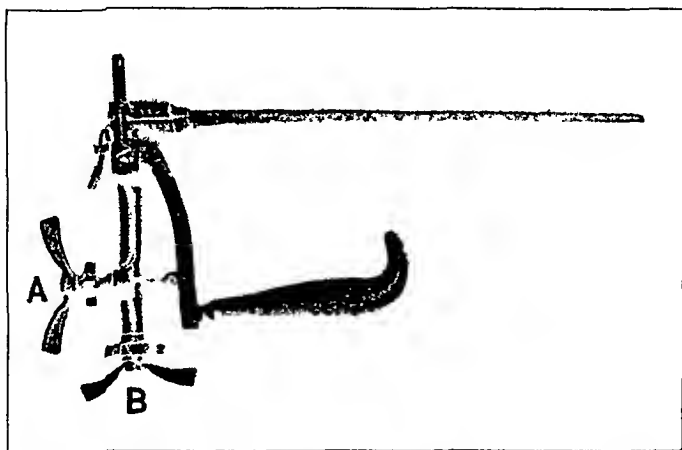


Fig. 1.—Expanding esophagoscope in closed position.

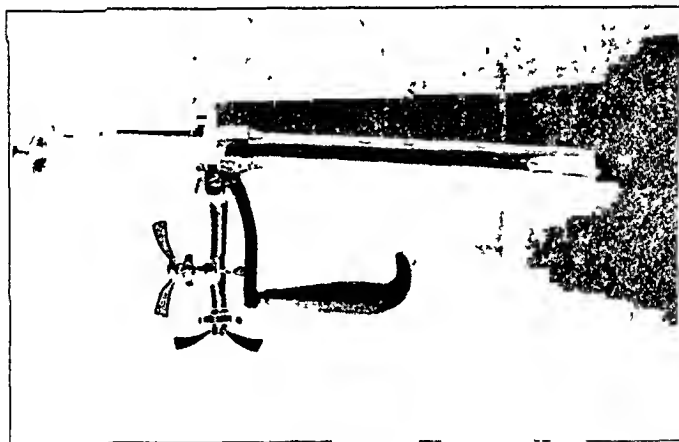


Fig. 2.—Extraction of a medium-sized foreign body.

The expanding esophagoscope with oval speculums was introduced into the upper part of the esophagus, and the foreign body was at once seen in the hypopharynx. It turned out to be a large piece of bone embedded in the swollen and inflamed mucosa. The difficult task of removing the bone without wounding the vulnerable mucosa was accomplished with the expanding esophagoscope. By carefully manipulating the instrument, which was gradually expanded and turned until it became possible to approach both the sharp ends of the bone, one of the ends was grasped and drawn into the tube with a pair of forceps. Withdrawing the instrument together with the piece of bone, further injury to the mucosa was avoided.

*Postoperative Course.*—Examination showed that the foreign body, which had been lodged in the hypopharynx for four days, had inflicted a serious wound there. A week later, in spite of this, the patient had completely recovered. The piece of bone removed was about 3.8 cm. long. It must be considered extraordinary that the patient recovered without any particular complications.

**CASE 2.**—A man aged 49 visited me and said that two days previously, when he was eating, something had become lodged in his throat. He complained of severe pain in the upper part of the thorax when swallowing. For two days he had taken only liquids, in small quantities, owing to the pain.

*Operation.*—With the area under local anesthesia, the expanding esophagoscope was easily introduced and the foreign body at once located. It turned out to be a long, thin piece of bone, the sharp end of which was embedded in the wall of the esophagus about 22 cm. from the front teeth. By carefully expanding the esophagoscope it was possible to grasp the free end of the bone, which also was

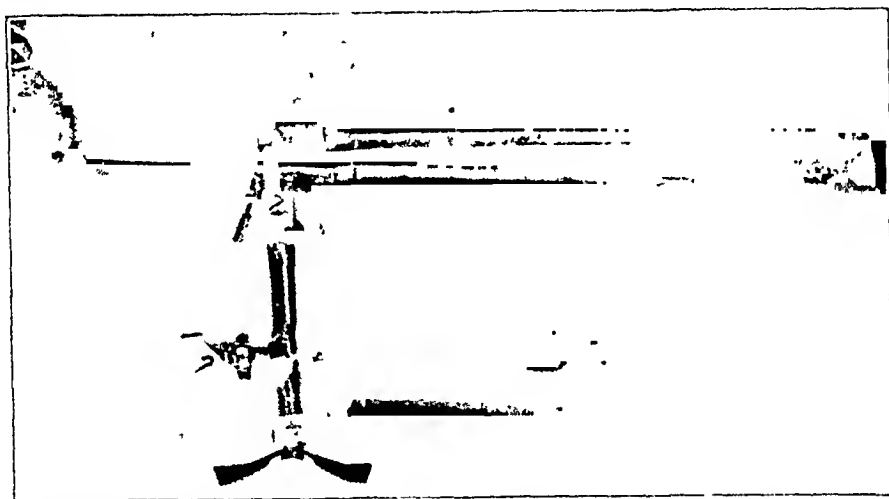


Fig. 3.—Extraction of a foreign body having sharp edges.

sharp, and to remove it without any further injury to the surrounding tissue. The patient recovered without complications.

My experience has confirmed the practical use of the expanding esophagoscope for the extraction of large foreign bodies from the esophagus. A particular advantage is the fact that the parts of the speculum can be adjusted to any position.

Another field in which the expanding esophagoscope proves useful is the extraction of small foreign bodies lodged in the upper parts of the esophagus or in the hypopharynx, which are often difficult to locate.

The following case is an example of this:

**CASE 3.**—A woman 56 years old felt that some foreign body was lodged in the upper part of her throat, a feeling that continued for several days. She went to a hospital, where she was examined carefully, but with the aid of an esophagoscope nothing could be found. As the patient still continued to complain that there was something in her throat, she visited me, and I made an examination using the expanding esophagoscope on March 10, 1938. The introduction of the instrument was effected not without difficulty, and at first only some inflammation of the



mucosa was seen. However, when the esophagoscope was expanded gradually, a small piece of bone was detected in the inflamed tissue of the lateral wall of the hypopharynx, and this was removed without difficulty.

CASE 4.—A man aged 39, after eating fish felt that he had swallowed a bone. He at once visited me, but I was unable to find anything. As the patient still insisted that there was a bone in his throat, the expanding esophagoscope was introduced, but at first nothing out of the way was noticed. However, when the instrument was expanded, the end of a thin fish bone was seen in the region of the piriform sinus. A closer examination revealed that the greater part of the bone was embedded in the mucosa, and it was extracted without difficulty, the patient recovering without complications.

It is often difficult to find foreign bodies in the region of the piriform sinus, especially when they are small and may easily escape detection.

Von Eicken,<sup>3</sup> with his great experience in the extraction of foreign bodies, spoke of the difficulty of finding them in the piriform sinus and

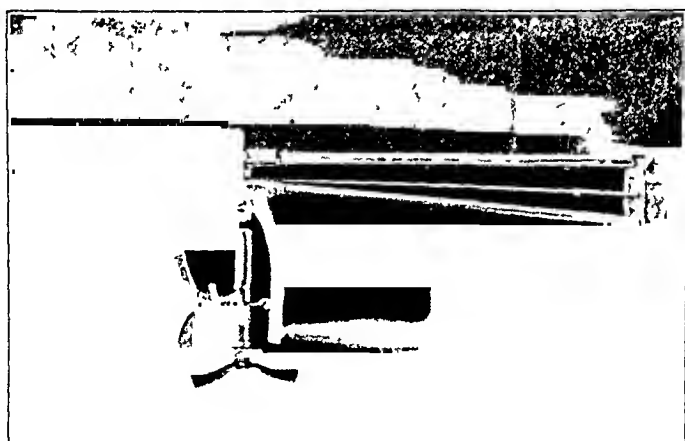


Fig. 4.—Extraction of a large foreign body.

said that if examination of the esophagus gives a negative result, a careful inspection of this region must be carried out. Because the region of the piriform sinus is wide and it is difficult to make a close examination with an ordinary esophagoscope, the expanding esophagoscope is of great assistance in such cases.

The expanding esophagoscope proves useful, too, for the extraction of sharp bodies, because it protects the mucosa of the esophageal wall from further injury. By expanding the tubes it is possible to grasp foreign bodies and draw them into the speculum, which itself protects the esophageal wall.

CASE 5.—A 29 year old man swallowed a bone when eating soup and later found it impossible to swallow at all. He complained of pain and came to me for treatment.

3. von Eicken, C.: Ueber 3 bemerkenswerte Fremdkörper der Speiseröhre, *Ztschr. f. Hals- u. Ohrenh.* 4:163, 1923.

Esophagoscopic examination revealed a large piece of bone embedded in the mouth of the esophagus. Closer examination showed it to have jagged edges. By expanding the tubes of the esophagoscope it was possible to seize one end of the bone with one pair of forceps and the other end with a second pair. Approaching the end of the esophagoscope to the bone, one could draw it into the tubes and in this way remove it completely without further injury to the tissue.

Generally speaking, the advantage of the expanding esophagoscope is that in its closed position it is easily introduced without inconvenience to the patient and that it can then be adjusted to the desired width and the distance between the parts of the speculum set as required.

In practice the expanding esophagoscope is used as follows:

The instrument is introduced in its closed position. Screw *A* (fig. 1) is then turned, opening the tubes at the ends. By moving screw *B* the two tubes are made parallel to each other.

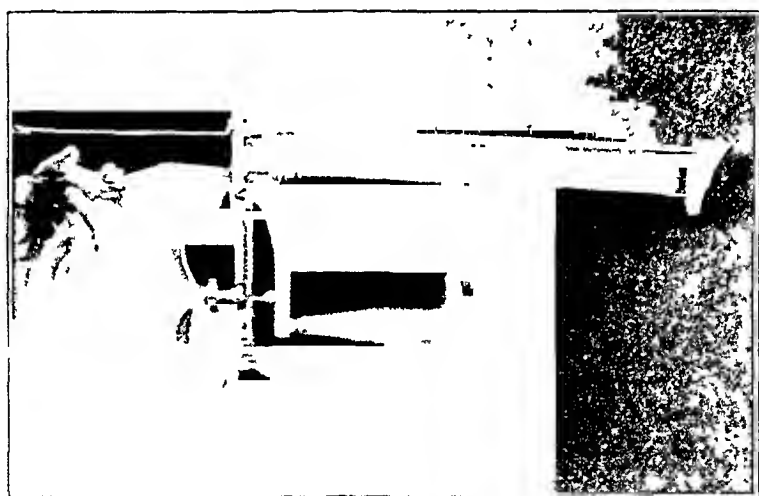


Fig. 5.—Extraction of a foreign body with two pairs of forceps

Various-shaped tubes can be adapted for certain purposes.

The oval tube is used for the extraction of large foreign bodies, while for the purpose of examining the hypopharynx the grooved tube is preferable.

I first used the expanding esophagoscope about ten years ago. At first all attempts to adapt existing instruments (those of Hill Brünings, Seiffert, Haslinger, Killian, Dufourmentel, Claoué and others) to my purpose failed, and it was necessary to construct an instrument on an entirely new principle. After numerous attempts, I succeeded in designing an instrument, and it was demonstrated before the Société de Broncho-Oesophagoscopie in Paris in 1935<sup>4</sup> and 1936<sup>5</sup> and before the

4. Matis, E. I.: Un nouvel œsophagoscope dilatable, *Bronchoscop., œsophagoscop. et gastroscop.*, 1936, p. 14.

5. Matis, E. I.: Démonstration de quelques perfectionnements du broncho-œsophagoscope dilatable, *Bronchoscop., œsophagoscop. et gastroscop.*, 1937, p. 11.

International Otolaryngologic Congress in 1936. In recent years the instrument has been improved. On the basis of experience gained in the use of the expanding esophagoscope, I consider that the instrument well serves the purposes mentioned in this paper and widens the possibility of extracting foreign bodies from the esophagus, especially those which are large, are embedded in the tissue, are sharp and with jagged edges or are difficult to find.

# OSSEOUS LESIONS OF NOSE AND SINUSES

WITH SPECIAL REFERENCE TO HYPERTROPHIC CHANGES AND  
TUMOR FORMATIONS

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PHILADELPHIA

The bones of the nose and sinuses are not uncommonly subjected to hypertrophic changes. These changes are usually considered to be neoplastic and are ordinarily diagnosed and treated as osteoma. In the study of a group of cases that have come under my observation, I found that there is considerable confusion as to the exact meaning of the term "osteoma." To the pathologist it is a term under which he discusses many forms of overgrowth of bone. To the laryngologist it is a definite clinical entity. He considers it a tumor originating in the bones of the nose and sinuses, encroaching on the cavities, and giving rise to symptoms of deformity, displacement, obstruction and pressure.

Ewing<sup>1</sup> stated: "Circumscribed overgrowth of bone occurs under such a wide variety of conditions and the distinctions between inflammatory and neoplastic hyperplasia of the tissue are so often obscure that it has never been possible to exactly define the limits of osteoma." He also mentioned that Borst, who separated from the tumors all the bone-producing processes which are self limiting or clearly associated with trauma and inflammation, had little to say about true osteoma.

At the present time there is an extensive literature available on osteomas of the nasal cavity and paranasal sinuses. It is concerned chiefly with the gross and clinical aspects of the lesion. Case reports and reviews of the literature have been frequent in the past decade, so that the general characteristics from a clinical standpoint are well understood. In the majority of the case reports scant discussion has been given to the histopathologic observation and pathologic interpretation of the lesions, in an effort to establish their basic nature.

The interesting feature of the cases that have come under my observation has been that grossly or clinically they were distinguished as tumors but that microscopically it was often impossible to classify them as true neoplasms. The limits of osteoma have not been defined. The

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Presented as a candidate's thesis to the American Laryngological, Rhinological and Otological Society, May 1939.

1. Ewing, J.: *Neoplastic Diseases*, ed. 3, Philadelphia, W. B. Saunders Company, 1928.

distinction between bone formation of neoplastic origin, i. e., a true tumor, and processes following trauma, inflammation and disturbance of nutrition which result in bone formation is obscure. A number of writers agree that neoplastic qualities occur in many bony lesions in which trauma, inflammation or nutritional disturbances were originally concerned. The neoplasia is a secondary rather than a primary process.

Davies-Colley<sup>2</sup> classified osteoma under the focal forms of fibrocystic disease of bone, often called osteitis fibrosa. This is not to be confused with von Recklinghausen's disease, which is a generalized disorder of bone due to dysfunction of the parathyroids. He considered it part of a group of tumors comprising a wide range of growths, beginning at one end of the scale with a tumor composed of pure fibrous tissue, generally encapsulated and conforming with the accepted definition of fibroma, and reaching at the other end of the scale a tumor composed of dense bone—the compact osteoma. Between these extremes are intermediate forms illustrating every degree of proportionate admixture of the two substances, bone and fibrous tissue. In assigning a cause for their development he expressed the belief that trauma is sufficient. They are considered to be disordered reparative processes in response to injury, and the completeness of their departure from the normal reactions places them among the neoplasias.

The pathologic action of trauma on the bone as a cause of the development of osteitis fibrosa was considered by Lang.<sup>3</sup> He regarded osteitis fibrosa as a secondary process, dependent on circulatory disturbances the result of trauma. If one considers that many of the so-called osteomas are but variants in the osteitis fibrosa group, a similar origin for them must be thought of. From such a point of view one does not try to define or separate such lesions into neoplastic and hypertrophic but regards them as combinations of the two. From my study such a broad conception better fits many of these osteomatous lesions. They may be placed in this somewhat loosely defined group of fibrocystic lesions of bone and related to focal osteitis fibrosa, solitary bone cyst and the benign giant cell tumor. Geschickter and Copeland<sup>4</sup> considered solitary bone cyst and osteitis fibrosa as a variant of a lesion which begins as a giant cell tumor resulting from trauma. My investigation indicates that some of the osteomas of the bones of the nose and sinuses may be included in this group. The essential primary process is one of healing or repair with new bone formation, and the sequence of events would be: trauma—giant cell tumor—bone cyst—osteitis fibrosa—osteoma. I

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2. Davies-Colley, R., in Discussion on Fibrocystic Disease of Bone, Proc. Roy. Soc. Med. 27:973-983 (May) 1934.

3. Lang, F. J.: Osteitis Fibrosa, Am. J. Path. 8:263-270 (May) 1932.

4. Geschickter, C. F., and Copeland, M. M.: Tumors of Bone, New York, American Journal of Cancer, 1931.

do not intend to infer that all osteomas are to be classified in such a way, as no doubt many are primarily true neoplasms and begin as such.

Such a thesis as to the etiologic nature of some of these osteomas may seem far afield to the laryngologist. However, it will be pertinent to compare some of the outstanding gross and microscopic characteristics of the lesions which fit in with this conception.

The age distribution is one of the outstanding clinical features of osteomas. They occur in early life, most often in youth up to the age of 30. Eckert-Moebius<sup>5</sup> reported 276 cases. The age was given in 163 and in 70 of these the osteomas occurred in the third decade. According to Armitage,<sup>6</sup> they occur in adolescence in 50 per cent of cases and before the age of 50 in 80 per cent. In the cases that I have studied the ages were: 28 (male), 21 (female), 19 (female), 14 (male), 16 (male), 21 (female). Geschickter and Copeland<sup>7</sup> gave a chart showing the age distribution of bone cysts and giant cell tumors in 400 cases. In 50 per cent these lesions occurred before the age of 31. I have plotted on this same chart the age grouping of osteomas in the 163 cases reported by Eckert-Moebius<sup>5</sup> (fig. 1). This similarity in age distribution does not prove a connection between the three types of lesion, but it gives a point in common which may be significant.

The incidence of trauma and its importance as a causative factor in cases of osteoma has been commented on by numerous writers (Gerber;<sup>8</sup> Culbert;<sup>9</sup> Garrettson;<sup>10</sup> Fetissof;<sup>11</sup> Carmody;<sup>12</sup> Fenton<sup>13</sup>). Of the cases which I have observed, there was a definite history of trauma in 2. Trauma is generally accepted as the important causative factor in the production of giant cell tumor, bone cyst and focal forms of osteitis fibrosa (Lang;<sup>3</sup> Geschickter and Copeland;<sup>4</sup> Lubarsch<sup>14</sup>).

5. Eckert-Moebius, A., in Denker, A., and Kahler, O.: *Handbuch der Hals-Nasen-Ohrenheilkunde*, Berlin, Julius Springer, 1926, vol. 5, p. 118.

6. Armitage, G.: Osteoma of Frontal Sinus, *Brit. J. Surg.* **18**:565-580 (April) 1931.

7. Geschickter and Copeland,<sup>4</sup> p. 244, fig. 161.

8. Gerber, P. H.: Les ostéomes du sinus frontal, *Arch. internat. de laryng.* **23**:1-17, 1907.

9. Culbert, W. L.: Multiple Osteoma of the Nasal Accessory Sinuses: Report of a Case Complicated by Syphilis; Operation; Autopsy, *New York State J. Med.* **18**:465-472 (Dec.) 1918.

10. Garrettson, W. T.: Osteoma of Frontal, Maxillary and Sphenoid Sinuses, with Report of Cases, *Arch. Otolaryng.* **5**:135-142 (Feb.) 1927.

11. Fetissof, A. G.: Pathogenesis of Osteomas in Nasal Accessory Sinuses, *Ann. Otol., Rhin. & Laryng.* **38**:404-412, 1927.

12. Carmody, T. E.: Osteoma of Nasal Accessory Sinuses, *Ann. Otol., Rhin. & Laryng.* **44**:626-643 (Sept.) 1935.

13. Fenton, R. A.: Osteoma Causing Nasociliary Neuralgia, *Ann. Otol., Rhin. & Laryng.* **42**:911-914 (Sept.) 1933.

14. Lubarsch: Die Bedeutung des Traumas für Entstehung und Wachstum krankhafter Gewächse, *Med. Klin.* **8**:1651-1654, 1912.

In spite of the great frequency of trauma in childhood, giant cell tumor, solitary bone cysts, osteitis fibrosa and osteoma occur in few children. Some other primary factor may play an important part. This may be related to nutritional or metabolic derangements, which are prone to affect the period of growth and development.

The site of origin is another interesting point of comparison between giant cell tumor of the head and osteoma. Geschickter and Copeland<sup>4</sup>

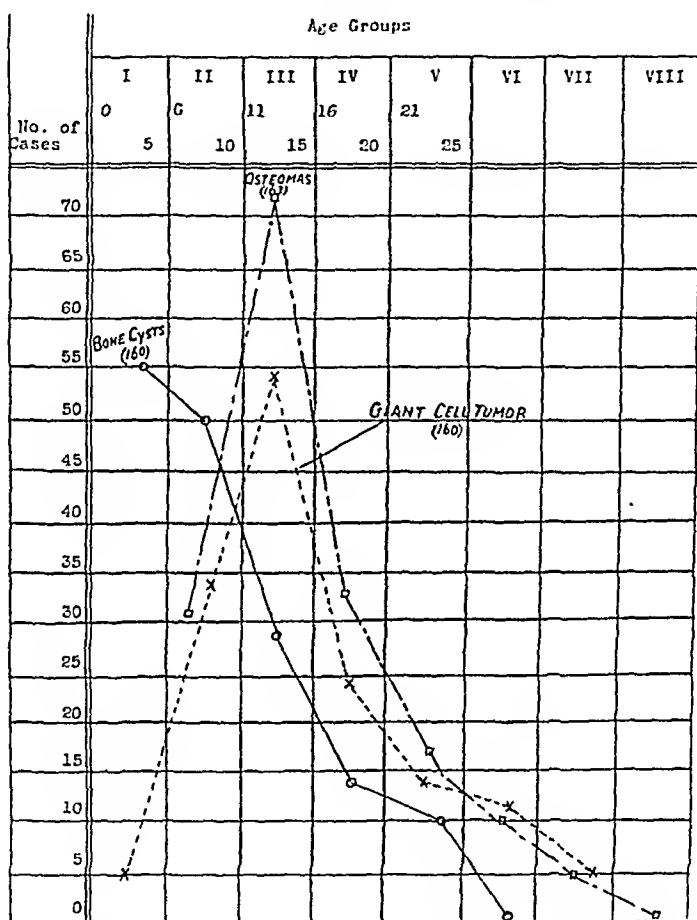


Fig. 1.—Age distribution of large numbers of bone cysts, osteomas and giant cell tumors.

studied this carefully in 22 cases of giant cell tumor occurring in the head from the records of the surgical pathologic laboratory of the Johns Hopkins Hospital. They found definite support for the belief that the origin of the pathologic process was at the sites of bone formed from cartilage.

The accompanying table, from Jordan and Kindred,<sup>15</sup> summarizes the essential points in the histogenesis of the chondrocranium. The same information is given diagrammatically in figure 2.

15. Jordan, H. E., and Kindred, J. E.: A Textbook of Embryology, New York. D. Appleton and Company, 1926.

If one studies the site of origin as observed in the large number of reported cases of osteoma, one finds that the most frequent sites coincide in locality with the centers of intracartilaginous ossification as outlined in the table and figure 2.

In Boenninghaus' <sup>16</sup> collection of 203 cases, the site was classed as frontal in 75 and as ethmoid in 36. Eckert-Moebius <sup>5</sup> records 276 cases,

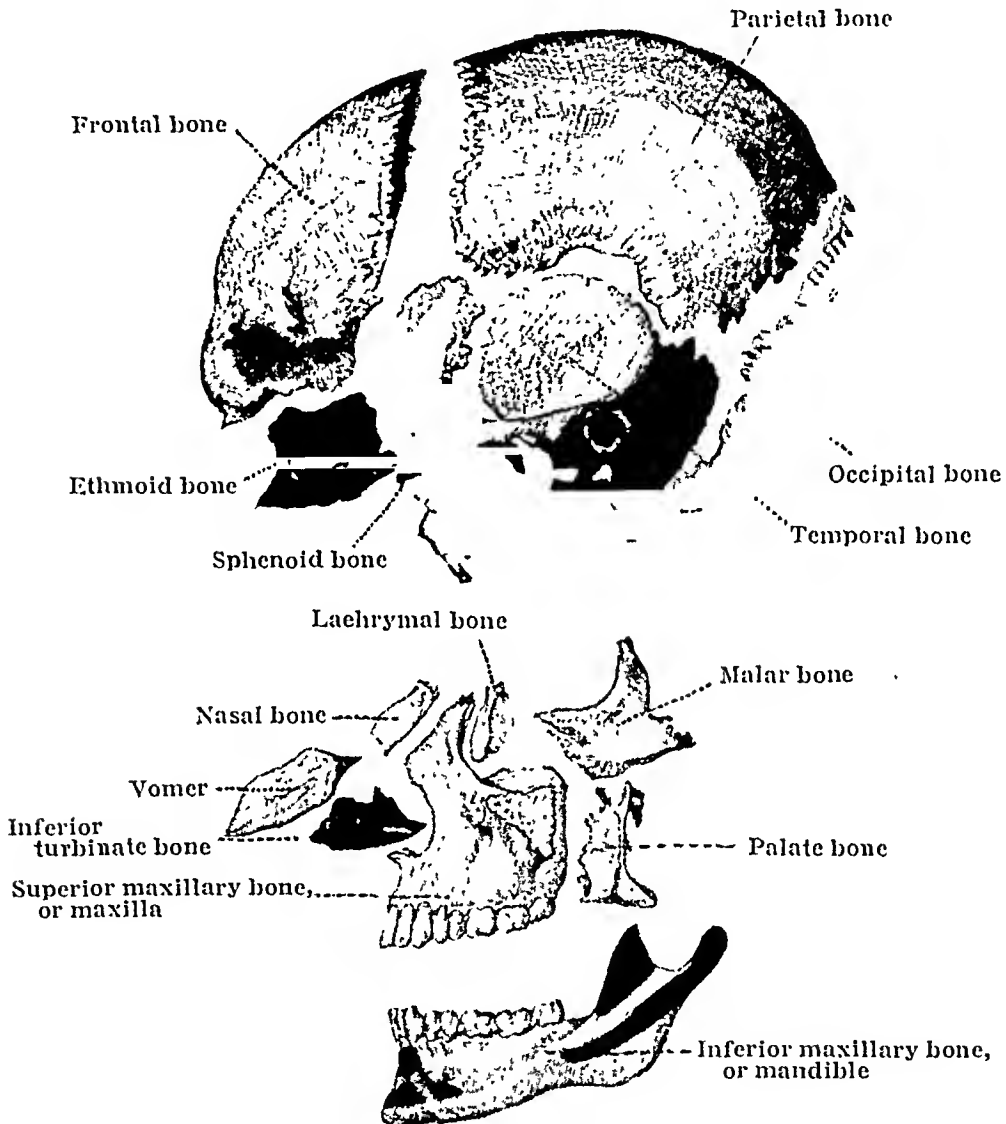


Fig. 2 (after Toldt).—The areas in black show the portions of the adult skull formed from cartilage. See the table.

in which the site of origin was as follows: extranasal, 20 cases; intranasal, 34 cases; frontal sinus, 113 cases; ethmoid cells, 56 cases; maxillary sinus, 13 cases; sphenoid sinus, 7 cases. Tillmanns <sup>17</sup> concluded

16. Boenninghaus, G., in Katz, L.; Preysing, H., and Blumenfeld, F.: *Handbuch der speziellen Chirurgie des Ohres und der oberen Luftwege*, Würzburg, Curt Kabitzsch, 1913, vol. 3, p. 222.

17. Tillmanns, H.: *Ueber todte Osteome der Nasen- und Stirnhöhlen*, Arch. f. klin. Chir. 32:677-690, 1885.



that the point of predilection was the ethmoid labyrinth and that the greater proportion of frontal osteomas really arose in the ethmoid cells. Many other investigators have concurred in this opinion. The common site of origin is thought to be the suture between the frontal and the ethmoid bones (Bornhaupt; <sup>18</sup> Arnold; <sup>19</sup> Knapp <sup>20</sup>). In my cases the site of origin was the maxilla in 1 case, the ethmoid labyrinth in 3 cases and the floor of the frontal sinus, probably the ethmoid level, in 1 case. One case of benign giant cell tumor was included in the study for comparison. The tumor was located in the right upper jaw.

*Relationships of Centers of Ossification of the Chondrocranium  
(from Jordan and Kindred <sup>15</sup>)*

Chondrocranial Regions	Centers of Ossification	Parts of Adult Skull
Occipital.....	{ Basioecipital.....	Basilar process of occipital bone
	{ Exoccipitals.....	Occipital condyles
	{ Supraoccipital.....	Squamous portion of occipital bone below the superior nuchal line
Sphenoid.....	{ Basisphenoid.....	Body of sphenoid bone
	{ Presphenoid.....	Body of sphenoid bone
	{ Lingulae.....	
	{ Alae magnae.....	Greater part of alae magnae
	{ Alae parvae.....	Alae parvae
Petrotic capsule.....	Petrous primordium.....	{ Petrous portion } of temporal bone
		{ Mastoid portion }
	Nasal septum (mesethmoid).....	{ Lamina perpendicularis Crista galli Nasal septum (cartilage)
Ethmoid.....	{ Paranasals (ectethmoids).....	{ Lateral masses of ethmoid bone Superior conchae Middle conchae
	{ Cribriform plates.....	Cribriform plates
	{ Inferior conchae.....	Inferior conchae
	{ Sphenoidal conchae.....	Sphenoidal conchae

Thus one may see, in comparing the influence of age, trauma and site of origin in these lesions (solitary bone cyst, benign giant cell tumor, osteitis fibrosa, osteoma) that there is a suggestive similarity.

Finally, an analysis of the histologic observations on a group of osteomas indicates that in many of the histologic features of some of them there is a resemblance to this fibrocystic group of lesions. This is illustrated in an examination of the histologic features of the cases reported here.

18. Bornhaupt, T.: Ein Fall von linksseitigem Stirnhöhlen-Osteom, nebst Bemerkungen über die in den Nebenhöhlen der Nase sich entwickelnden Osteome, Arch. f. klin. Chir. 26:589-644, 1881.

19. Arnold, J.: Zwei Osteome der Stirnhöhlen. Virchows Arch. f. path. Anat. 57:145-163, 1873.

20. Knapp, J. H.: Beschreibung eines Falles von elfenbeinerer Orbitalenostose, Arch. f. Ophth. (pt. 1) 8:239, 1861.

## REPORT OF CASES

CASE 1.—R. T., a white man aged 28, was first seen on July 7, 1925, complaining of complete obstruction of the right side of the nose. The family and the past medical history were not pertinent.

The nasal obstruction was of three or four months' duration. It was partial at first but gradually progressed until it was complete. There was no history of injury, epistaxis, nasal discharge, pain, headache or any discomfort aside from that due to the obstruction. There were no symptoms referable to the ears or eyes.

The general physical examination gave negative results. The urine was normal, and the Wassermann tests of the blood were negative.

Examination of the nose revealed a reddish granular-looking mass completely filling the right nasal chamber. A probe showed this to be a very hard substance, firmly fixed and unyielding, superficially covered anteriorly by dark reddish tissue, which bled freely when touched. When this was removed, a smooth grayish



Fig. 3 (case 1).—Photograph of the entire growth removed from the right nasal chamber. It measured 6 by 4.5 by 3 cm. and weighed 65 Gm.

surface came to light which had the appearance and consistency of bone. Palpation in the nasopharynx showed that the mass extended through the choana and was of similar hardness posteriorly. It completely filled the right nasal chamber. The left side of the nose appeared normal. The septum bulged somewhat into the left nasal chamber, owing to pressure from the mass on the right side. The report of the roentgen examination was as follows:

"There is a large bony growth, ovoid, occupying the entire right nasal chamber and spreading into the posterior nasal space on the right side. The nasal wall of the antrum has been pushed outward and the roof of the palate downward by pressure. Its point of origin is uncertain, but we believe it to be somewhere in the ethmoidal spaces. It is of even density and rather well circumscribed on all its borders."

The problem of operative removal was a difficult one. The mass was too large and too firmly fixed to be dislodged through the nares or the choana. It was like ivory in hardness and could not be broken up even with a dental drill. With the

patient under ether anesthesia, an incision was made beneath the upper lip and the nose retracted upward (sublabial rhinotomy, or Rouge's operation). The cartilaginous septum was divided near the floor of the nose and pushed to the left. The lateral nasal wall had been obliterated by pressure from the mass, and it was necessary to open into the right antrum in order to get around it. A portion of the superior alveolar margin of the maxilla was removed to enlarge the pyriform aperture and allow passage of the mass. It was finally delivered by the exertion of great force



Fig. 4 (case 1) —Photomicrograph ( $\times 200$ ) showing the histologic characteristics of a compact osteoma.

The tumor was found to be a very hard, eburnated bony growth. Its surface was light gray and relatively smooth. It was somewhat nodular. It measured 6 by 4.5 by 3 cm. and weighed 65 Gm. The entire growth appeared to be limited by a very thin fibrous capsule. Its point of attachment could not be definitely determined. However, it is thought there was a small pedicle attaching it to some point in the right ethmoid area which was broken away by the vigorous rocking and prying necessary in the removal of the growth. The microscopic examination, by Dr. Baxter L. Crawford, was reported as follows:

"Sections from the mass are composed of rather dense, compact bone, in which there are a number of vessels, varying in size. There is little connective tissue in the sections. The growth seems to be of uniform consistency and structure. Diagnosis: osteoma, compact type."

The interesting features of this tumor were: its large size, filling the right nasal chamber; its marked density throughout, classifying it with the hard variety of osteoma (*ossea eburneum*), and the absence of symptoms. Nasal stuffiness was the only complaint. The growth had the features of a true neoplasm, i. e., a spontaneous, noninflammatory origin, a progressive course, a circumscribed form. The site of origin was apparently the ethmoid labyrinth.

Osteoma is much more rarely seen in the nasal cavities than in the accessory sinuses. This has been emphasized by Ernst, Lubarsch<sup>14</sup> and others who have collected cases. Among approximately 92 references to the subject of osteomas of the nose and sinuses listed in the *Quarterly Cumulative Index Medicus* since 1918 there are only 6 references to osteoma of the nasal cavity. Guthrie<sup>21</sup> and Goodyear<sup>22</sup> each reported a case of osteoma arising in the nasal septum and projecting into the nasal fossa.

CASE 2.—R. B., a white girl aged 16, was first seen on April 21, 1926, complaining of disturbance of vision and bulging of the left eye. This had been present about two years, gradually becoming more marked. There was no diplopia and no pain. There was no history of injury.

The family history was not contributory.

At 6 years of age she had pneumonia complicated by a renal disturbance with edema of the face, hands and feet.

Physical examination showed rather marked bulging of the left eye due to a bony mass in the medial part of the orbit, which displaced the eyeball forward, downward and outward. There was no disturbance of the eyegrounds or media of the eye. The right eye was normal. The rest of the physical findings were unimportant. The nasal chambers were clear and unobstructed.

Roentgen examination showed a mass the density of bone, well circumscribed, with origin from the ethmoidal sinus, where there appeared to be some intracellular destruction. It had invaded the orbit and pushed the supraorbital plate upward.

On May 5, with the patient under nitrogen monoxide-ether anesthesia, an external incision was made along the lateral wall of the nose upward and out along the line of the eyebrow, and the lower part of the frontal sinus and the inner upper part of the orbit were exposed as in a radical operation on the frontal sinus. The bony growth was exposed, extending laterally from the ethmoid region and invading the orbit. It was about the size of a guinea hen's egg. It was white and almost as hard as ivory in consistency. It was removed in two pieces. The medial half attached to the ethmoid was freed with hammer and chisel. The left frontal sinus was not involved by the growth. The left nasal chamber was not entered.

21. Guthrie, T.: A Case of Osteoma of the Nasal Septum, *J. Laryng. & Otol.* 45:189-191 (March) 1930.

22. Goodyear, H. M.: Osteoma of Frontal Sinus Extending into the Orbit and the Anterior Cerebral Fossa, *Laryngoscope* 35:751-753 (Oct.) 1925.

Dr. Crawford reported on the pathologic examination of the lesion as follows: "The specimen consists of two irregular pieces of bone, one measuring 5 by 4 by 3 cm., the other 3 by 2 by 1 cm. They are nodular, covered by gray tissue and on section are very dense, hard and gray. Histologically, the masses are composed of very dense bony tissue, at the periphery of which there is little fibrous tissue,

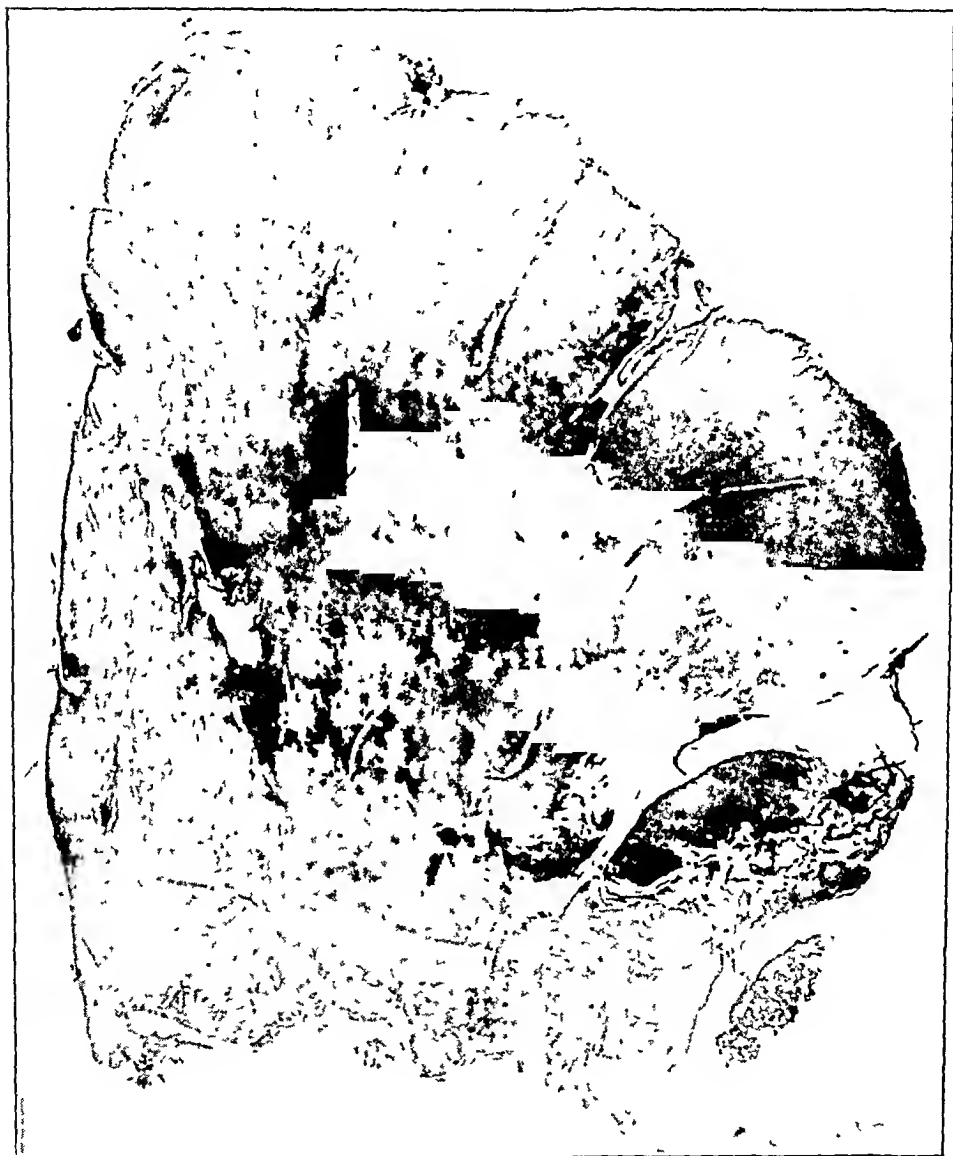


Fig. 5 (case 2).—Photomicrograph under very low power ( $\times 7$ ) showing the structure of a compact osteoma. Very dense bone is found at the periphery, with more fibrous tissue at the base of the attachment.

but a number of small irregular-shaped vessels. Near the tumor's base of attachment there is more fibrous tissue. Diagnosis: osteoma of the ethmoid, compact type."

From the clinical and pathologic study of this tumor it appears to be a true neoplasm, i. e., a true osteoma.

A number of cases of osteoma of the orbit have been described. Knapp<sup>20</sup> reported 4 cases of osteoma of the orbit, in each of which the point of origin was a paranasal sinus; these cases he found in a series of 56,000 cases. He believed that the most frequent site of origin was the

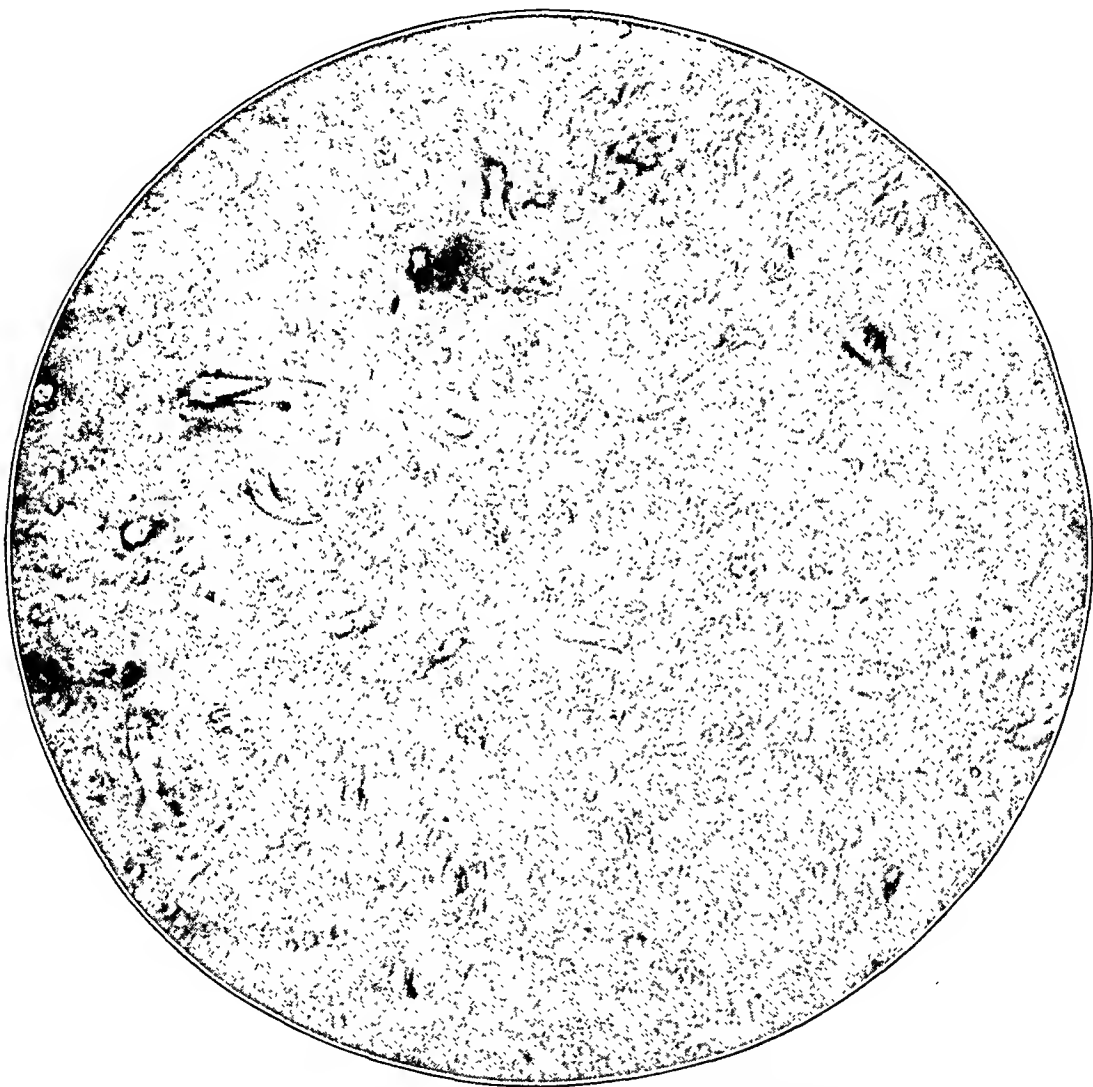


Fig. 6 (case 2).—Photomicrograph ( $\times 100$ ) showing the histologic structure of a compact osteoma similar to that in case 1.

floor of the frontal sinus. Andrews<sup>23</sup> compiled 8 cases from 439,000 cases of ocular disease. Bornhaupt<sup>18</sup> compiled 23 cases in which the growth originated in the bones of the frontal sinus and 26 other cases of osteoma of the orbit in which the growth originated in the bones of the

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23. Andrews, J. A.: Successful Removal of Two Osteomata of the Orbit: One Originating in the Frontal, the Other in the Ethmoidal Cells with a History of Osteomata of the Neighboring Pneumatic Cavities of the Orbit, *M. Rec.* **32**:261-274 (Sept. 3) 1887.

ethmoid sinus. The common site of origin for a bony growth of the orbit is the upper inner segment. Ewing<sup>1</sup> stated that such osteomas not infrequently appear as congenital tumors in young girls. Virchow<sup>24</sup> concluded that they arise as enostoses of the orbital wall. He described 4 osteomas, in some of which cysts were found, lined by ciliated epithelium. Such a possibility must be thought of in this case, the growth remaining latent for some time and then being stimulated to active growth by some unknown exciting factor during the rapid period of bony growth and development characteristic of this period of life.

There is no element in the gross or microscopic aspects of these 2 tumors to indicate that they were a part of any other pathologic process than a true neoplasm.



Fig. 7 (case 3).—Photograph of the patient showing swelling of the left side of the nose and inner canthus of the left eye, pushing the eyeball laterally.

CASE 3.—F. N., a white boy aged 14, was first seen on May 3, 1934, complaining of swelling of the left side of the nose and inner canthus of the eye, pushing the eyeball laterally. This was first noticed three years previously, following a blow in this area in August 1931. The swelling was directly related to the trauma.

The family history was not remarkable.

The past medical history was free of any serious illness or anything that could be related to the present complaint except for the history of trauma at the site of the growth. The patient thought that the swelling had not increased in size for the past few years.

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24. Virchow, R.: *Die krankhaften Geschwülste*, Berlin, A. Hirschwald, 1864-1865, vol. 2.

Physical examination revealed a pale, undernourished youth with no systemic disease aside from some secondary anemia. The hemoglobin content was 70 per cent; the red blood cell count was 4,700,000. The Wassermann and Kahn tests of the blood were negative. The blood phosphorus and calcium were within normal limits.

The right eye was normal. The left eye was pushed to the left, and the vision was blurred as in case 2. At the inner angle of the eye a hard bonelike mass was palpable. The overlying skin was freely movable and appeared normal. It was sensitive to pressure. The mass appeared to spring from the bone of the left ethmoid sinus and projected toward the orbit.

The nasal chambers were not remarkable and were free of obstruction or evidence of inflammation. The left middle turbinate appeared prominent and somewhat enlarged.



Fig. 8 (case 3).—Photograph of the patient after operation, showing the return of the left eye to approximately its normal position.

The roentgenologist's report was as follows: "There is a circumscribed mass of increased density about the size of a half dollar, which seems to arise in the left ethmoid area. It extends lateral to the internal wall of the orbit and fairly well posterior. It does not seem to have destroyed the wall of the orbit, however. I get the impression that it is an osteoma. The sinuses are fairly well developed and well aerated."

The growth was removed May 11, 1934, with the patient under gas-ether anesthesia. It was exposed by means of an ethmofrontal incision as in an external approach to the ethmoid and frontal sinuses. It was sharply demarcated from the surrounding bone; it extended medially to the nasal septum and upward to the floor of the frontal sinus, and laterally it distended the medial side of the orbital plate, which was atrophied by pressure from the growth. The orbit was not invaded. The mass seemed to be attached to, and to spring from, the ethmoid region. It was irregular on its surface and about 1 inch (2.5 cm.) in diameter.



The mass was separated from surrounding tissue but was fragmented in the attempt to remove it in one piece. It had quite a hard surface or outer shell, which was easily broken. The inner part was rather spongy or cancellous. It was very much like breaking through a hard surface into a cystic cavity made up of spicules of bone and soft tissue. An opening was made into the left nasal cavity and the area packed with iodoform gauze from below and closed externally. The recovery was uneventful.

The histopathologic examination, by Dr. Baxter L. Crawford, was reported as follows: "The specimen consists of small pieces of soft bony tissue. The largest measures 1.5 cm. in its greatest dimension. Some portions of the bone seem to be shell-like in consistency. Examination of sections from the specimen reveals that it is composed of rather cellular bony tissue in which there is much

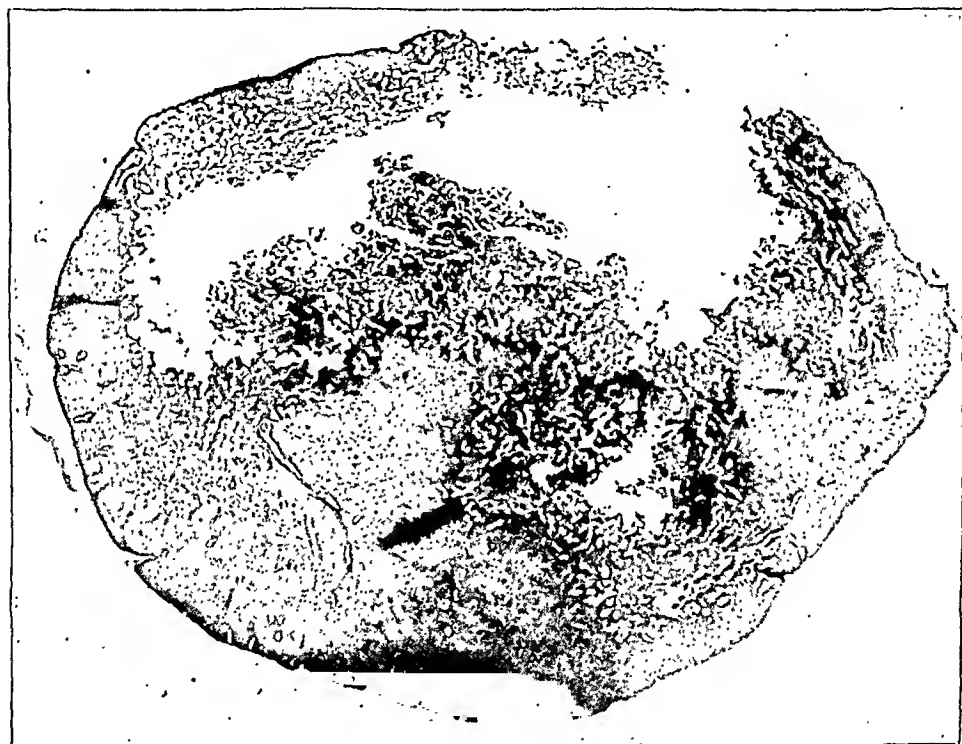


Fig. 9 (case 3).—Photomicrograph under very low power ( $\times 7$ ) showing the structure of an osteomatous growth from the left ethmoid area. There is a hard outer shell of compact bone. The central spongy area of cellular tissue is made up of bone and connective tissue, in which, near the center, there is a cystlike area.

fibrous tissue. In some areas at the margin the bone is quite dense. Throughout the greater portion there are spicules of bone in which there is considerable cellular fibrous tissue. About the center of the larger piece there seems to be an area of degeneration or a small cyst."

From the microscopic picture one would be unable to distinguish sections of this lesion from those of osteitis fibrosa. A study of the photomicrograph illustrates the structure composed of bone and connec-

tive tissue. The large cells at the margin of the bone are considered to be osteoclasts, some of which are multinucleated. This suggests absorption of bone as well as bone formation and might easily be representative of a reparative or healing process following an earlier bone destroying stage in the pathologic process.

From the gross and clinical characteristics this could properly be classed and treated as osteoma. However, with a definite history of



Fig. 10 (case 3).—Photomicrograph ( $\times 100$ ) to illustrate the structural composition of the lesion, which is made up of bone and connective tissue. The large cells at the margin of the bone are considered to be osteoclasts, some of which are multinucleated, suggesting absorption of bone as well as bone formation. The histologic structure is similar to that of osteitis fibrosa.

trauma and the resemblance histologically to a healing reaction termed osteitis fibrosa, there is considerable doubt as to whether it should be considered primarily as a true neoplasm.

CASE 4.—E. D. R., a white boy aged 16, was first seen on Aug. 13, 1931, with marked swelling, redness and tenderness over the left frontal sinus. The left eye

was closed by the swelling and edema of the surrounding structures. There were no nasal symptoms, such as obstruction or discharge. It appeared at first that this was acute frontal sinusitis with involvement of the soft tissue. The roentgenologist gave the following report: "There is an osteoma in the inner canthus of the left eye which involves the supraorbital ridge of the left frontal sinus. It is irregular in outline and no doubt has a rather broad attachment."

The boy's history revealed that a year and a half prior to this he struck his head at the root of the nose, smashing the septum and nasal bones and leaving a lump on the nose extending down to the inner canthus of the left eye. It

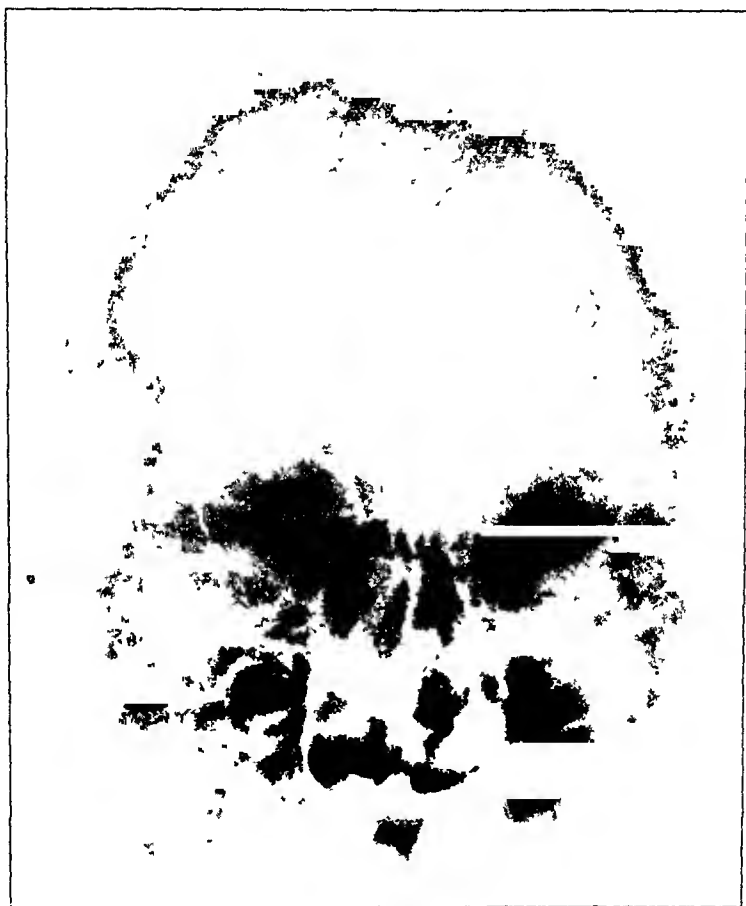


Fig. 11 (case 4).—Roentgen film showing the left frontal sinus completely filled with the tumor mass, which extends also into the right frontal sinus.

gradually increased in size, and in the summer of 1930 he first noticed some swelling of the forehead. The lump was gradually encroaching on his left eye. About a month prior to coming to the clinic he was struck heavily at the site of the growth during a fist fight. The acute symptoms of cellulitis with redness, swelling and tenderness followed.

The family history was unimportant.

Examination showed the left eyelids closed by the swelling and edema and marked tenderness with fluctuation over the swelling above the eye. The nasal chambers were clear, and there was no evidence of sinus infection.

An incision was made beneath the left brow and a considerable quantity of pus drained out. The cellulitis rapidly subsided, and the hard swelling of the tumor mass was readily palpated at the inner upper wall of the left orbit and over the inner third of the left frontal bone.

A second roentgen study was made after the acute inflammation had subsided and was reported as follows: "There is evidently a lesion involving the left frontal sinus in which there is some dense mass, the density being almost that of bone. It apparently is accompanied by thickening of the orbital wall and seems to project into the orbit. I should think the lesion is probably in the nature of an osteoma and probably a benign growth.

"The direct posteroanterior films show that the left frontal sinus is completely filled with the tumor mass and I believe that this mass is extending also into



Fig. 12 (case 4).—Roentgen film taken after operation, showing the amount of bone removed from the frontal area.

the right frontal sinus as well as into the left orbit. From the density of it I am reasonably certain that it is composed largely of bone tissue and that it has probably originated in the floor of the left frontal sinus."

The first operation to remove the growth was done in March 1932. It was exposed by an incision made through the eyebrow and around the lateral wall of the nose as for a radical operation on the frontal sinus. A large part of the growth was removed from the left frontal sinus, including the extension into the orbit. However, it was not completely removed. The swelling returned in the left frontal area and was accompanied by pain. It increased slowly but gradually, and a second operation was performed July 24, 1934. At this time there was resection of the frontal area, including both frontal sinuses and the inner and outer table of the skull.

A histologic description of the sections from the growth by Dr. Baxter L. Crawford follows: "The specimen removed in March 1932 is composed of large, irregular-shaped bone trabeculae separated by connective tissue of loose texture in which are numerous blood vessels. There seem to be small hemorrhages in the connective tissue, but no definite necrosis or cyst formation is observed.

"The specimen of tumor finally removed by resection of the frontal area two years later is composed of bone and connective tissue. The structure of the tissue varies considerably in different areas. Some parts are composed largely of rather dense bony tissue, in which there are a few haversian canals, and the tissue is rather dense, with few cells and considerable homogeneous staining intercellular substance. In the other places the fibrous tissue predominates. It is cellular and loose in texture and contains many blood vessels. Throughout the fibrous tissue there are many various-sized spicules of bone. The fibrous tissue is much more cellular and vascular in some areas than in others, but definite evidence of inflammatory reaction is not observed. In some of these areas the bone is evidently being absorbed, as there are numerous osteoclasts present, many of which are multinucleated. In the connective tissue there are numerous blood vessels and also larger spaces filled with blood, and in some instances, hemorrhage in the tissue. Attached to one of the pieces is a bit of mucosa composed of columnar epithelial cells. There is nothing noted in the histologic structure to indicate a definite neoplasm. The picture resembles that of osteitis fibrosa."

The blood calcium and phosphorus were within normal limits.

Some interesting features of this case are: the definite history of injury followed by evidence of the growth; the comparatively rapid growth following the incomplete removal; the similarity of the microscopic picture to that of osteitis fibrosa suggesting that factors other than a primary tumor growth influence lesions of this type.

CASE 5.—M. M., a white girl aged 19, was first seen on May 8, 1929, complaining of painless swelling of her right cheek bone of about a year's duration. She had no nasal symptoms. She had received roentgen treatment at another hospital over a period of six months. No change was noted in the swelling or enlargement of the right cheek bone. Examination revealed a hard swelling of the right maxillary region from the alveolar margin to the orbit. It was not tender, and there was no apparent involvement of the soft tissues. Two upper right premolar teeth were removed along with some bone.

The histologic report on sections from the tissue removed was as follows: "The tissue is composed of cellular bone, in which there are areas of extensive fibrous tissue. In the fibrous tissue comparatively few blood vessels are observed. A few small fragments are composed almost entirely of very dense fibrous tissue. A number of sections were cut and examined, but there was no evidence of rapid growth or irregularity of the cells to indicate malignancy. The histologic diagnosis was fibroosteoma."

After this surgical intervention no change occurred until May 1934, when it was noted that the cheek was more prominent. Four months later, about September, she began having shooting pains in her right cheek, and the mass had become considerably larger. She was again admitted, October 1, five and a half years after the first admission.

Examination showed the right maxilla to be very prominent, the swelling extending to and elevating the right nasal bone. The upper right teeth and



Fig. 13 (case 5).—Photograph of the gross specimen, the right superior maxilla, removed at operation. Note the marked thickening of the entire bone and the nodular surface.



Fig. 14 (case 5).—Roentgen film showing the appearance after the removal of the right maxilla.

the entire right side of the palate had been pushed downward to a lower level than the left side. The vessels in the mucous membrane of the gums and palate were prominent. There was a denture at the site of the operation performed five and one-half years ago. There was no fistula or discharge and very little scarring. There were no symptoms referable to the nose or throat, and the general physical examination did not show anything remarkable. Determinations of blood components were: sugar, 86 mg.; calcium, 10.48 mg.; phosphorus, 5.42 mg.

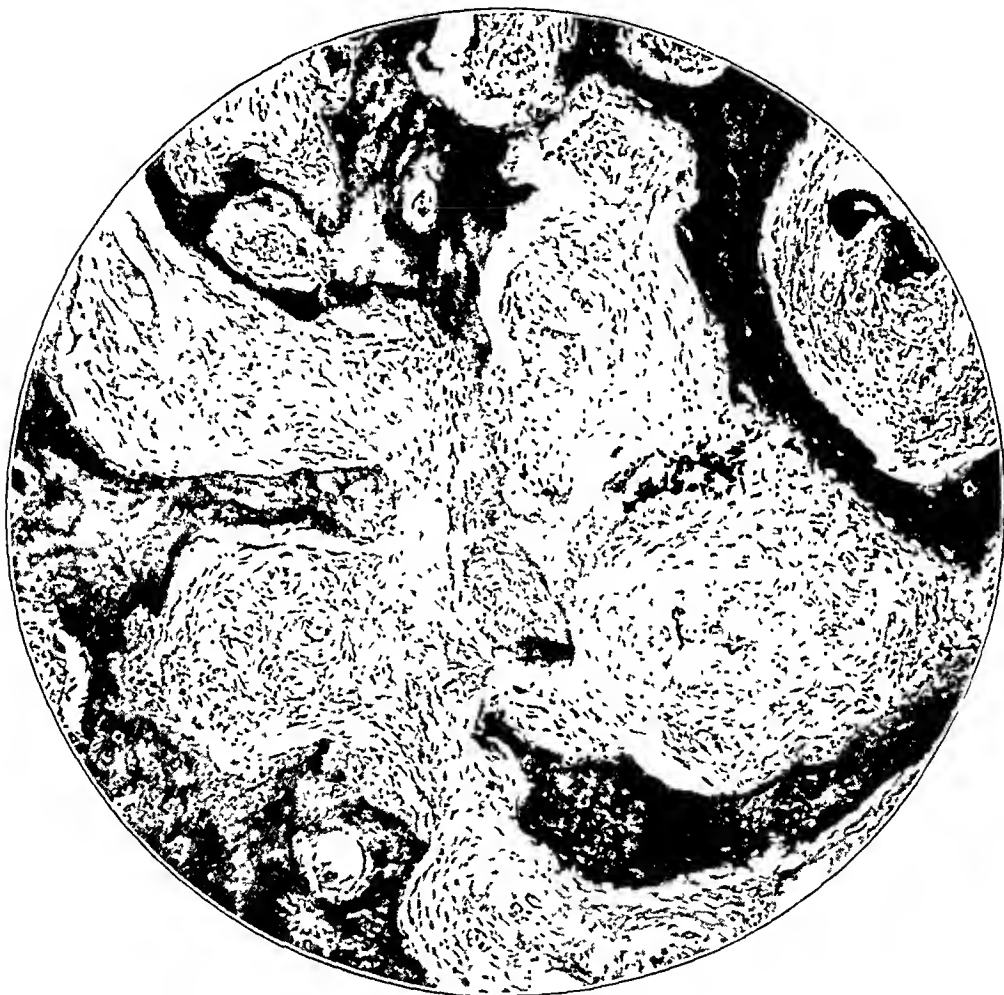


Fig. 15 (case 5).—Photomicrograph ( $\times 200$ ) of sections from the superior maxilla showing a structure composed of bone and cellular connective tissue similar to that seen in osteitis fibrosa.

She was operated on, October 2, under anesthesia induced by avertin with amylene hydrate, supplemented with ether. The anterior part of the maxilla, including most of the hard palate and remaining right upper teeth, was removed in one mass. This included the entire growth.

The report of the microscopic examination by Dr. Baxter L. Crawford follows: "Sections from the superior maxilla are composed of bone trabeculae, which vary in size and shape, and are scattered throughout connective tissue. The tissue is

vascular, but the arrangement of normal haversian systems is lacking. The connective tissue is quite abundant in areas and has a myxomatous appearance. No evidence of inflammatory reaction is observed. There are numerous small hemorrhages with necrosis and small cyst formations in the connective tissue. The histologic structure of sections from various parts of the lesion is essentially the same, with variation only in the proportion of bone tissue and connective tissue.

"The structure of this lesion is similar to the changes in the bone observed in osteitis fibrosa, but because of the nodular formation and the encroachment on

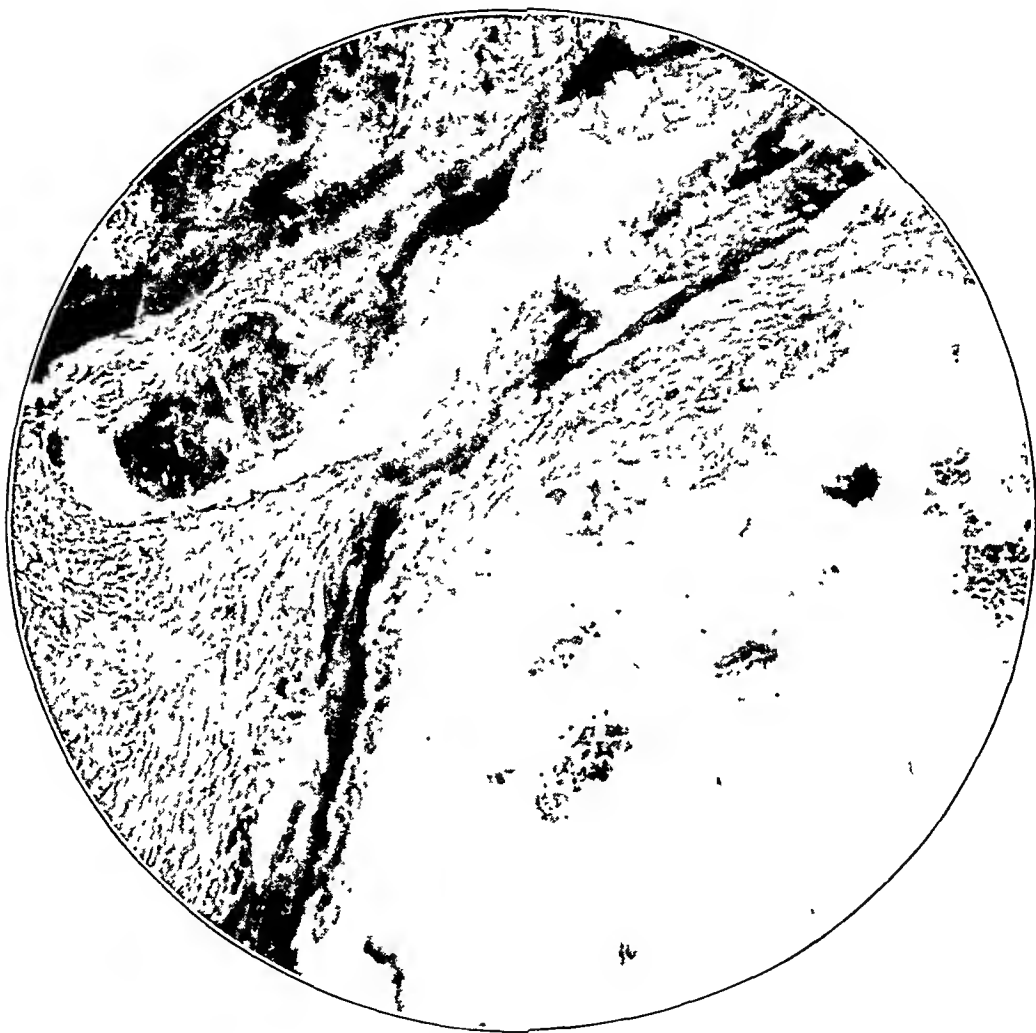


Fig. 16 (case 5).—Photomicrograph ( $\times 100$ ) of a section from the superior maxilla showing an area composed of fibrous tissue and bone, with the formation of a small cavity or cyst.

the sinuses it is classed as a neoplasm. Diagnosis: osteoma of the superior maxilla, porous type."

CASE 6.—C. P., a white woman aged 21, was first seen on May 1, 1926, complaining of headache and of pain and enlargement of the right cheek. Her discomfort began six years previously, at the age of 15 years, with headache, then pain over the right cheek and gradual enlargement of the right cheek bone. There was no history of injury.



Physical examination showed apparent asymmetry of the face due to prominence of the right maxilla. The right alveolar ridge was enlarged and firm. The nose and throat were not remarkable. There was no evidence of sinus infection.

A piece of the enlarged right maxilla was removed for biopsy, the report on which, by Dr. Baxter L. Crawford was as follows: "The specimen consists of a number of bony fragments of tissue, the larger piece measuring 2 by 1 by 2.5 cm. While all of the tissue is bony, it is of spongy consistency.

"Microscopic examination shows the tissue composed of rather large irregular bone trabeculae scattered through connective tissue of loose texture, which con-



Fig. 17 (case 6).—Roentgen film showing increased density from the presence of a benign giant cell tumor over the region of the right maxilla.

tains many blood vessels. There are a number of foci composed of cellular connective tissue, in which are numerous large multinucleated cells. No definite inflammatory reaction is observed, but there are a number of small hemorrhages and necrotic areas in the connective tissue with the formation of cystic areas. Diagnosis: benign giant cell tumor of the bone."

Roentgen treatment was given for the lesion. The patient was not seen until six years later, when she was again admitted complaining of pain in the right side of her face. The enlargement of the right maxilla was no greater, producing slight asymmetry of the face. The roentgen report was as follows: "There is quite a bit of increased density over the region of the right maxillary antrum,

apparently due to thickening of the bone rather than to any particular material in the antrum."

The roentgen therapy was repeated. Unfortunately a biopsy was not made at this time. It would have been exceedingly interesting to compare the histologic appearance with that of the specimen removed six years earlier.

This lesion although histologically diagnosed as benign giant cell tumor has many of the characteristics of the lesion in case 5. The main

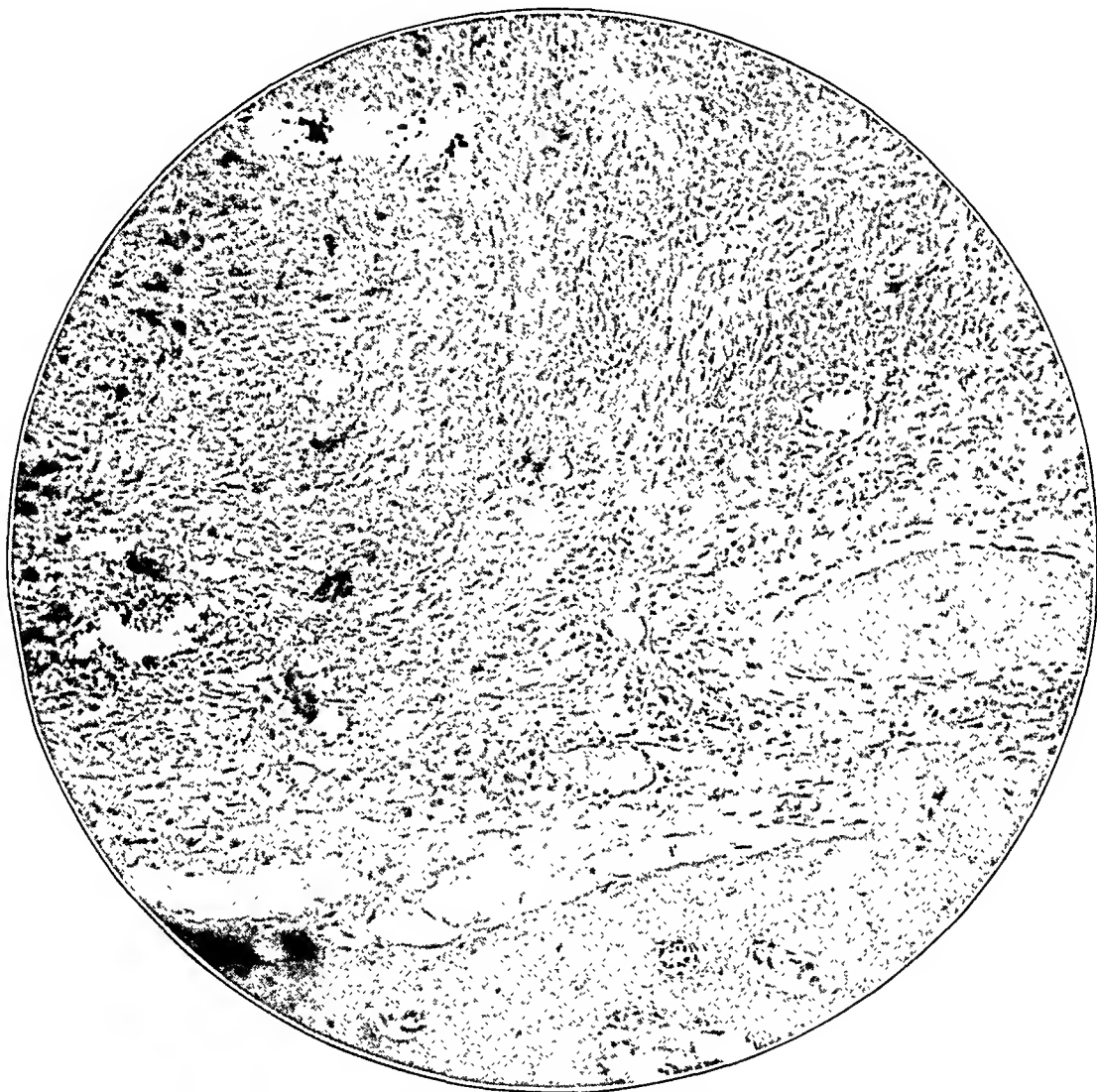


Fig. 18 (case 6).—Photomicrograph of benign giant cell tumor ( $\times 100$ ) showing presence of bone tissue and cellular fibrous tissue in which there are numerous multinucleated giant cells.

distinguishing feature is the numerous giant cells. However, as one may see in examining the histologic picture in cases 3 and 4, multinucleated cells occur in lesions considered to be osteomas, although they are much less numerous. The similarity is certainly sufficient to indicate, as stated earlier in this paper, that the two pictures represent

different stages of the same pathologic process rather than two distinct pathologic entities. The osteoma may be the secondary element and signify a terminal product in a series of transformations of tissue which began as a giant cell tumor.

In summarizing the histologic study of these lesions one sees that those in cases 1 and 2 can be considered primarily as true neoplasms or osteomas of the compact variety. The spontaneous origin, progressive course, circumscribed form and composition of simple compact bone give a definite picture of tumor formation. In cases 3, 4 and 5 the growths have rather typical gross and clinical features indicative of true osteomas, but they cannot be differentiated as such by the histologic study because of the presence of features which are also characteristic of other hypertrophic lesions of bone, namely, the so-called fibrocystic group. In other words, they may be lesions which have taken on secondarily neoplastic properties but which primarily began as another process—probably a reparative process in response to injury or trauma.

The last case was cited to illustrate the similarity grossly and histologically of typical giant cell tumor to the tumor formation of the osteoma in case 5.

#### SUMMARY

In a study of hypertrophic changes and tumor formations in bone lesions of the nose and sinuses one finds that in contrast to the well established gross and clinical features of the lesions there is a great deal of uncertainty as to the pathologic interpretation. The majority are treated as osteomas and are thought of as neoplasms.

Osteoma as a true neoplasm has not been clearly distinguished from other forms of overgrowth of bone. It appears to be pathologically related to the so-called fibrocystic group of bone lesions. Because of the number of instances in which one finds that it combines the clinical features and histologic characteristics of both giant cell tumor and osteitis fibrosa one feels that they may be closely allied, and the possibility of a common cause must be considered. Some form of trauma seems to be the most important etiologic factor. Some other metabolic or nutritional disturbance may be necessary to account for such an abnormal reaction, and further clinical and histologic investigation should be carried out to establish the basic nature of these processes. A better understanding of the etiologic factors may reveal that in the cases in which the lesion cannot be definitely proved to be a true neoplasm, radical surgical intervention with the attendant deformity, in an attempt to eliminate the condition, is not necessary.

Dr. Baxter L. Crawford helped in the study of the histologic sections, and Dr. Carl J. Bucher, in the translation of the foreign texts.

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# VASCULAR FIBROMA OF THE NASOPHARYNX (NASOPHARYNGEAL FIBROMA)

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## CAUSES

Vascular fibroma of the nasopharynx, an interesting and peculiar type of tumor, occurs chiefly in males and rarely in females between the ages of 10 and 25 years and seems to be related to the growth and maturation of the bones of the base of the skull. Consequently spontaneous regression can and does occur, though infrequently. The neoplasm is not common but is of the utmost importance because of an active growth which may interfere with various functions. Ulceration and local infection may take place, or severe anemia may result from repeated hemorrhage, while fatal consequences from intracranial extension or from injudicious attempts at removal are not uncommon. A tendency toward recurrence is typical. In this country, Delavan<sup>1</sup> has contributed extensively to the existent knowledge of the growths.

## SITE OF ORIGIN AND GROWTH

The tumor is thought to originate in the periosteum of the bones which arise from the embryonal occipital plate (the basilar process of the occipital bone, the body of the sphenoid, the medial pterygoid process and the bones in the region of the foramen lacerum and the pterygo-palatine fossa) and the anterior aspect of the first two cervical vertebrae.<sup>2</sup> Its growth is slow and expansive, and it may invade the pharyngeal, nasal or paranasal cavity, the superior or inferior orbital fissure, the regions of the masseteric compartment and the temporal fossa, the foramina at the base of the skull or the cribriform plate (fig. 1). It may be difficult to determine the site of origin of the tumor because of this extensive growth, the susceptibility to profuse bleeding on manipulation and the secondary attachments which may occur. Although the tumor neither metastasizes nor infiltrates tissue in the manner of sarcoma, its spread is destructive, because of pressure necrosis.

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From the Department of Otolaryngology, Rush Medical College.

Read before the Chicago Laryngological and Otological Society, April 3, 1939.

1. Delavan, D. B., in Jackson, C., and Coates, G. M.: *The Nose, Throat and Ear and Their Diseases*, Philadelphia, W. B. Saunders Company, 1930, p. 181-186.

2. Ringertz, N.: *Acta oto-laryng.*, 1938, supp. 27, pp. 1-405.

## PATHOLOGIC PICTURE

Macroscopically the fibroma may be pink to deep red and may resemble a nasal polyp. Microscopically it is made up principally of connective tissue and an unusually large number of blood and lymph vessels.<sup>3</sup> In the latter respect the tissue differs from that of true fibroma and, for the sake of accuracy, might more appropriately be termed "vascular fibroma" or "angiofibroma." The connective tissue is for the most part collagenous, and the reticulum is shown by Foote stains to be of delicate texture. Elastic connective tissue is infrequent.

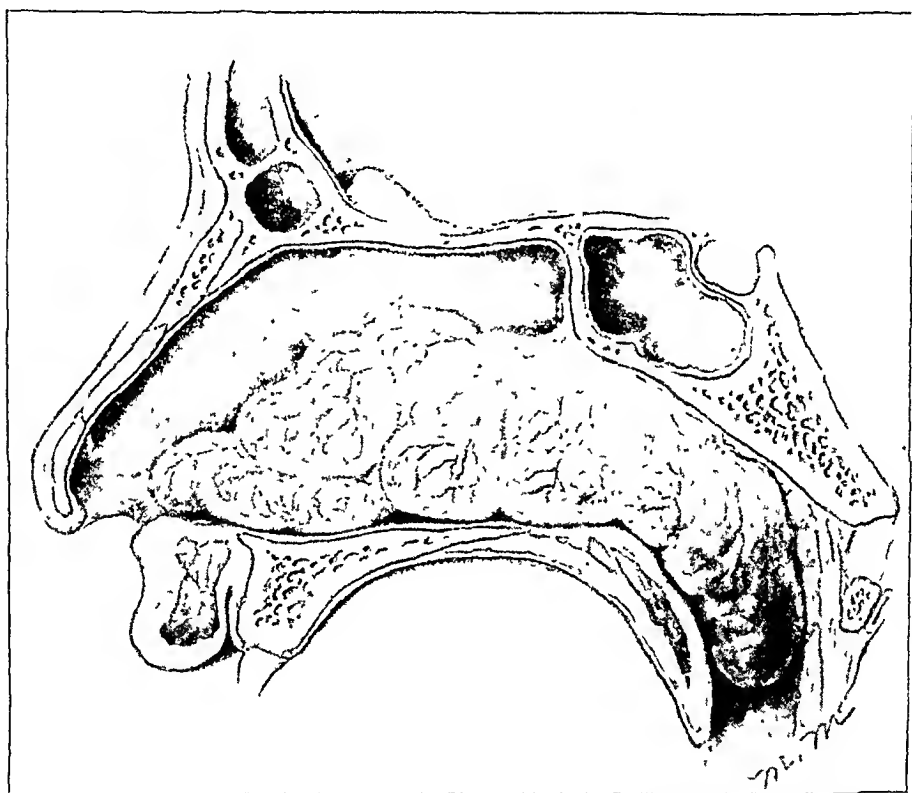


Fig. 1.—Extensive vascular fibroma of the nasopharynx. The apparent site of origin is at the base of the sphenoid sinus (Lederer<sup>6</sup>).

The fibroblasts may be round or spindle shaped and have a tendency to appear in focal distribution. The cells may be immature and their number greater than in adult connective tissue. In fact, isolated areas may be suggestive of sarcoma. The blood vessels are thin walled, vary in size and may even be cavernous. Because they are embedded in fibrous tissue and lack a muscular layer, the vessels do not collapse when cut and hence bleed profusely.

3. Ewing, J.: *Neoplastic Diseases*, ed. 3, Philadelphia, W. B. Saunders Company, 1934, p. 181.

Calcification, cartilage and osseous formations have been described in connection with this tumor. During retrogression or involution, changes of the walls of the blood vessels may ensue, with resulting necrosis, fatty degeneration or hyalinization of the tumor.<sup>3</sup>

The surface of the neoplasm is covered by mucous membrane, the epithelium of which may undergo metaplasia. No evidence of formation of a capsule is apparent. In contrast to teratoid tumors, not infrequently observed in this region, there is a lack of smooth muscle fibers.<sup>4</sup>

In summary it may be repeated that, while histologically benign, vascular fibroma of the nasopharynx is clinically malignant in its growth.

#### SYMPTOMS

In the early stages there may be no symptoms, but once the growth has attained sufficient size, obstruction to nasal respiration usually becomes manifest. The increased size may be responsible for changes in the character of the voice, suppuration in the accessory sinuses and obstruction to the eustachian orifices, with deafness or disease of the middle ear. Bleeding is one of the most important symptoms and may be either spontaneous or induced by attempted removal. Surface ulceration causes early bleeding, while fatal hemorrhage may result from involvement of large vessels.<sup>5</sup> Extension into the pharynx may produce dysphagia. Severe and intractable pain is apt to be the consequence of pressure on nerve trunks.

With the spread of the tumor into the sphenoid and ethmoid regions, optic atrophy, proptosis and even basilar meningitis ensue, while invasion of the maxillas may lead to the often described "frog face" deformity. Anemia from repeated loss of blood and cachexia from toxic absorption further burden the patient. Spontaneous regression, though occasionally noted between the ages of 25 and 30, cannot be relied on, particularly in young persons or in adults whose existence is threatened by the extent of the growth.

#### DIAGNOSIS

In addition to the usual methods of examination, the nasopharyngoscope may be employed with benefit, especially in searching for recurrences. Roentgenograms, particularly basal and lateral views of the skull, are helpful in defining the extent of the tumor. If necessary, examination with the patient under general anesthesia should be performed. Biopsy is essential, although if vascular fibroma is suspected one might well defer the procedure until irradiation has decreased the vascularity of the growth. Surgical diathermy is invaluable for the con-

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4. Henke, F., and Lubarsch, O.: *Handbuch der speziellen Pathologie und Histologie*, Berlin, Julius Springer, 1926, vol. 3, pp. 222-224.

5. Goldsmith, P. G.: *J. Laryng. & Otol.* 38:565-574, 1923.

trol of any bleeding which follows examination or removal of tissue for microscopic study.

The question of differentiation from sarcoma may arise, but correlation of clinical and microscopic aspects should be decisive in this respect. It is questionable whether this tumor ever undergoes malignant degeneration.

Lederer<sup>6</sup> has pointed out that adenoid masses, particularly after attempted removal, may resemble fibroma and that, conversely, an abnormality is sometimes not considered until repeated unsuccessful attacks on the nasopharynx have been made. Teratoid tumor, hemangioma and lymphangioma deserve consideration, as, of course, do the more common varieties of nasal or choanal polyp. The last are lighter in color than true vascular fibroma, do not bleed as freely and present a widely different histologic picture. It must be remembered that malignant chordoma occurs in this region. Carcinoma of the nasopharynx is not as uncommon in younger persons as was formerly thought and should always be excluded.

#### REPORT OF CASES

CASE 1.—M. B., a boy aged 11, was first examined by Dr. T. C. Galloway on May 11, 1934, because of purulent postnasal secretion. The tonsils were large and spongy, and there was thought to be a polyp above the right middle turbinate bone. Tonsillectomy and adenoidectomy were performed on June 29, and at that time a mass was discovered filling the right choana and extending from above the middle turbinate to the lower palatal border. The mass measured about 3 by 2 cm., was of firm, boardlike consistency and cut with great difficulty with the snare. It seemed to be attached above the orifice of the right eustachian tube. Bleeding was fairly profuse but controllable with pressure. The tissue was examined microscopically and vascular fibroma was reported.

Radon seeds were implanted into the pharyngeal mass for two years, between October 1934 and October 1936, with a total dose of 1,900 millicurie hours. There was a decrease in the tumor and some accompanying atrophy of the turbinate, but a definite growth persisted in the region of the eustachian tube.

In November 1936, with the patient under anesthesia induced by nitrogen monoxide and ether, nasopharyngeal examination was performed, a Haslinger palate retractor being employed. A snare was passed through the nose. By means of visualization and palpation the tumor was engaged and removed with coagulating current. Grossly the tissue was roughly spherical, measuring 22 by 18 by 20 mm. The histologic diagnosis was benign fibroma, and histologic evidence of any effect of irradiation was not present (fig. 2).

After this removal the nasopharynx was smooth. The right maxillary sinus was dark on transillumination, but the finding was ascribed to a sinusal infection due to previous blockage. Some months later, because of epistaxis without gross signs of recurrence, a roentgenogram was taken; a mass was noted which filled the medial two thirds of the right antrum (fig. 3). The patient then began to

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6. Lederer, F.: *Diseases of the Ear, Nose and Throat*, Philadelphia, F. A. Davis Company, 1938, p. 425.

complain of headache on excessive activity and stooping. There was a slight fulness over the right cheek and brow.

In July 1938, with the patient under anesthesia induced by avertin with amylene hydrate, an incision was made through the right canine fossa with the idea of ligating the internal maxillary artery as a preliminary measure. A soft friable tumor was encountered which bled freely when touched. The right external carotid artery was ligated with little effect on bleeding. (In retrospect it appears that radium, roentgen rays or radon should have been used at this time, with subsequent removal of the tumor.) The operation was continued, with coagulation

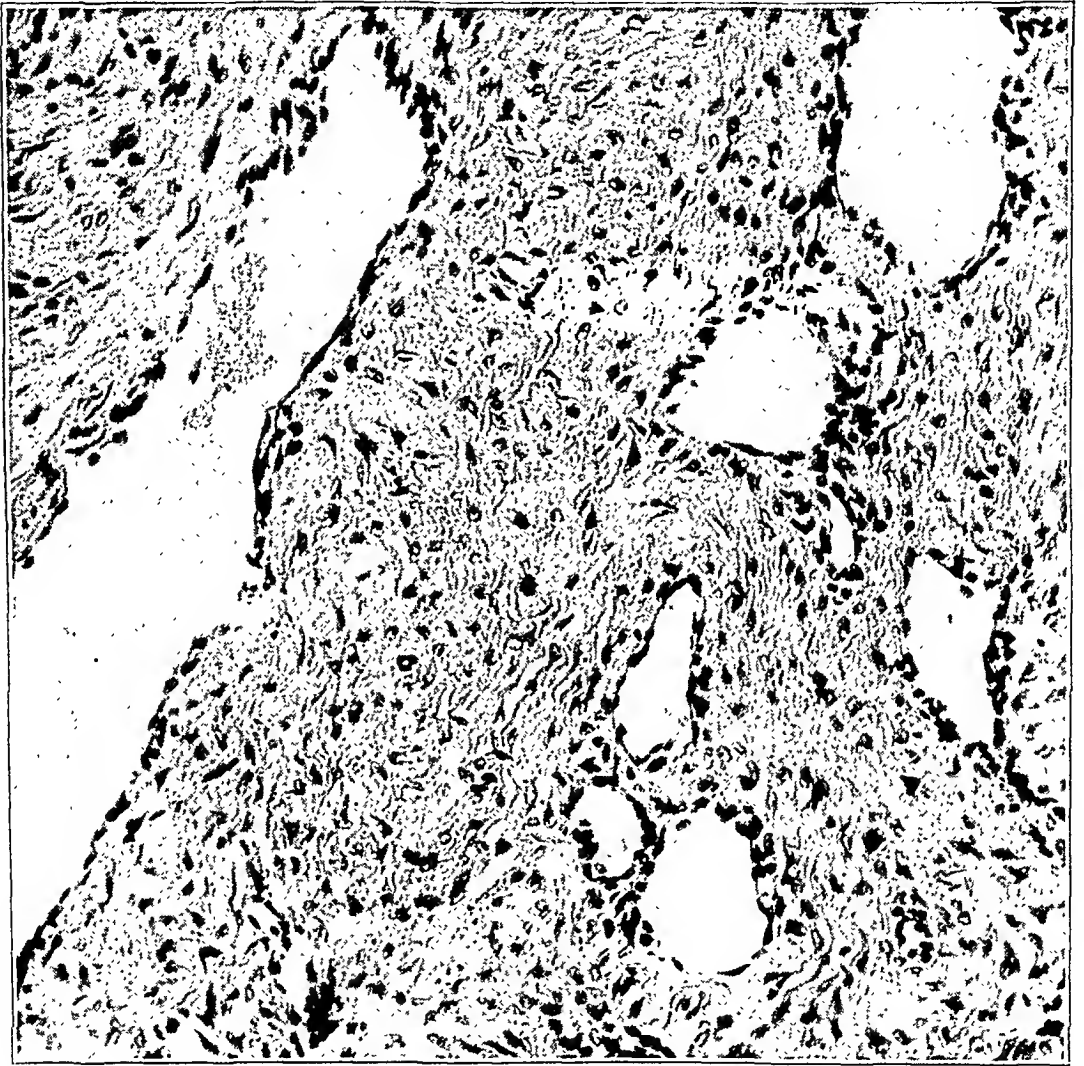


Fig. 2 (case 1).—Section of vascular fibroma after two years of radiation therapy. This section does not show alterations as compared with those removed prior to irradiation. The histologic picture is typical of the growth, with fibroblasts and thin-walled vessels predominating.

and removal of tissue by forceps but despite suction the field was almost entirely obscured by blood. The tumor nearly filled the antrum and had eroded its posterior wall in the medial half, filling the sphenomaxillary fossa. Removal seemed complete after coagulation and Luc forceps had been used, though the internal maxillary artery or its branches could not be visualized. Bleeding was controlled by iodoform packing. The loss of blood was estimated at 700 cc., and a transfusion



was given immediately. A postoperative blood pressure of 70 systolic and 40 diastolic later rose to 116 systolic and 50 diastolic.

Four days later, on July 11, the packing was removed, and profuse hemorrhage ensued. The internal maxillary artery was ligated, but packing had to be reinserted. The operation was discontinued because of the poor condition of the patient, and the blood pressure rose to 180 systolic and 50 diastolic for no known cause. The antrum and the nasal fossa were packed and the sublabial incision left open. Several days later, when the packing was again removed, the resulting oozing seemed to emanate from several large veins and arteries in the vicinity, which were ligated, the procedure including the sphenopalatine artery and a large branch going to the inferior turbinate. The operative field then became dry, but a petrolatum gauze pack was left in situ. When this was removed, five days later, there was no further bleeding, and the sublabial wound had healed without suture. The patient's hemoglobin had decreased from 15 Gm. (97 per cent) to 10 Gm. (64 per cent).



Fig. 3 (case 1).—Roentgenogram illustrating recurrence of growth. The original tumor had completely disappeared, and the recurrent mass had grown into the right antrum via its posterior wall and the sphenomaxillary fossa.

Microscopic examination of the tissue disclosed epithelium of the respiratory tract covering a cellular tumor with a fibrous stroma and many small to medium-sized vascular channels.

In September and again in December examination of the antrum and sphenomaxillary space (by means of a nasopharyngoscope passed through the antrum window) did not reveal evidence of any tumor tissue.

CASE 2.—C. M., a boy aged 15, had been having frequent nosebleeds and nasal obstruction for one year when first seen by Dr. T. C. Galloway, in June 1937. The epistaxis had been occurring with increasing frequency. There had been many head colds, and the patient had lost weight. The family history was noncontributory. Two previous attempts had been made to remove a mass from within the nose, both of which had been attended by severe bleeding. On examination

a growth was seen filling the left nasal chamber nearly to the vestibule and extending into the nasopharynx as a 3 cm. red, rounded mass attached by a somewhat smaller pedicle. The neoplasm was smooth and covered by dilated vessels and bled profusely when touched with a rounded forceps. The bleeding was controlled by packing for one hour and coagulating diathermy. Biopsy revealed a cellular vascular fibroma, the fibroblasts being ovoid to spherical, with sparse chromatin and a prominent nucleolus. Lymphocytes, macrophages and plasma cells were notably absent.

With the patient under local anesthesia, six 1 millicurie gold radon implants were inserted into the body of the tumor. Bleeding was moderately profuse but controllable with diathermy. There were 4,560,000 red blood cells, 71 per cent hemoglobin, and 11,550 white blood cells, per cubic millimeter. Four months later, after eight additional 1 millicurie gold radon implantations, the original mass



Fig. 4 (case 3).—Roentgenogram illustrating a large shadow of soft tissue in the region of the left sphenoid.

was approximately one-third its original size and firmer and bled much less readily. A total of 1,862 millicurie hours of radon had been used thus far.

In March 1938 the growth extended posteriorly from the anterior tip of the left middle turbinate into the nasopharynx and was adherent to the choanal border of the turbinate and the nasal septum in this region. In filling the left choana, it seemed to arise from a pedicle above the orifice of the eustachian tube. With the patient under anesthesia induced by avertin with amylene hydrate and nitrogen monoxide, the nasal and nasopharyngeal masses were electrocoagulated and then removed with coagulating snare and forceps. The left external carotid artery was ligated because of severe bleeding. All raw surfaces were coagulated and desiccated, and iodoform packing was inserted. There was mild postoperative shock, and the packing was removed in twenty-four hours, with no further bleeding. Biopsy disclosed benign capillary hemangiofibroma, and appreciable changes in the histologic picture were not present.

Considerable crusting appeared subsequently, and in April a small sequestrum of the anterior wall of the sphenoid sinus was removed. In September a small vascular region near the posterior remnant of the middle turbinate received 400 millicurie hours of radon. Biopsy of this tissue, however, revealed only a chronic inflammatory (plasmocytic) reaction, with none of the fibrovascular characteristics of earlier specimens.

In December the previously involved areas were smooth and clean save for a small mass seen through the defect in the sphenoid. One 1 millicurie radon

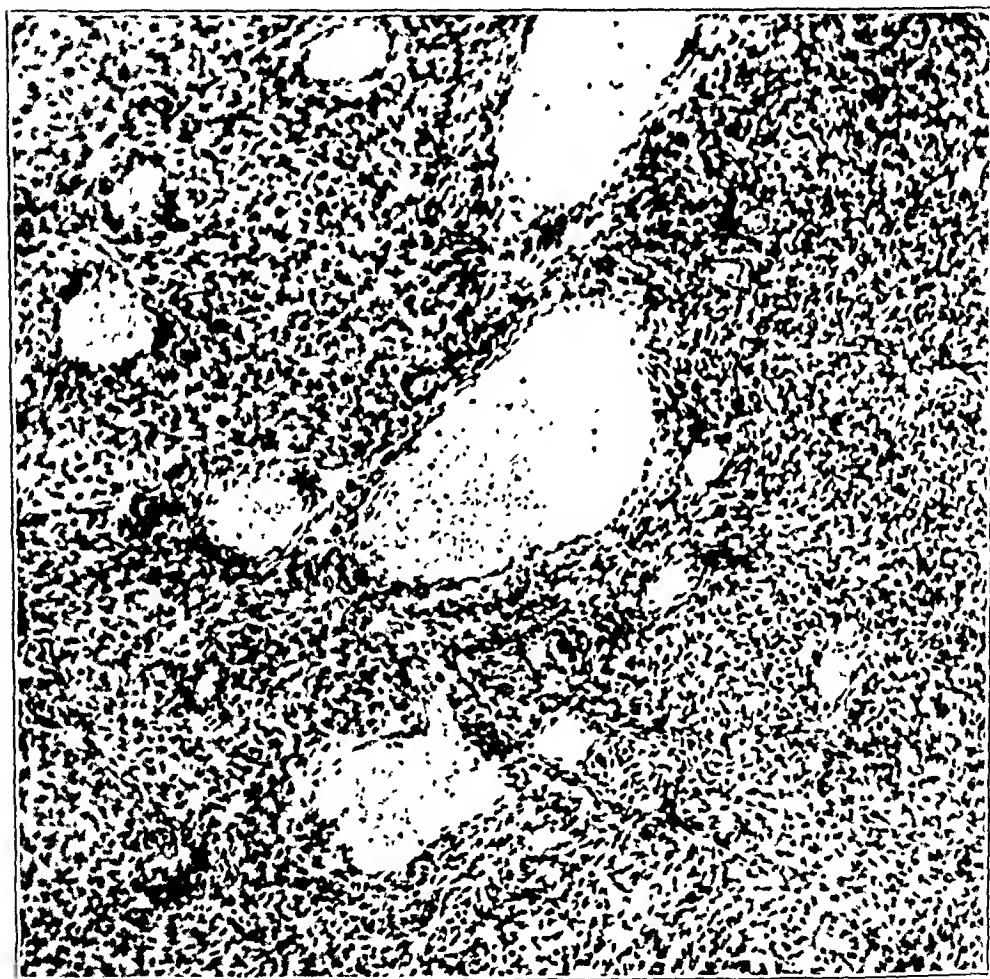


Fig. 5 (case 3).—Section of the original tumor showing typical vascular fibroma. The extreme cellularity is noteworthy.

seed was implanted, the total dose being brought to 2,400 millicurie hours. The patient had gained 20 pounds (9 Kg.) and was playing basketball, and the only difficulty, some crusting, was controlled by daily nasal douches.

CASE 3.—Mr. A. L., aged 26, was first seen by Dr. L. T. Curry on Jan. 6, 1938, at which time he told of having had marked nasal obstruction on the left side for one year. During the week prior to examination there had been frequent spontaneous hemorrhages from each side of the nose. There had not been pain

or aural symptoms. On anterior rhinoscopic examination, a large red tumor was seen filling the region normally occupied by the left middle turbinate and obscuring all but the anterior tip of the inferior turbinate. This mass bled profusely during attempts to shrink the blocked passage. On posterior rhinoscopic examination, a similar tumor was observed filling the entire left side of the nasopharynx superiorly, blocking the left choanal opening and extending partially across the right choana, obscuring the septum. There was a slight bluish discoloration over the handle of the malleus on the left tympanic membrane. The right ear was normal. Cervical enlargements were not present.

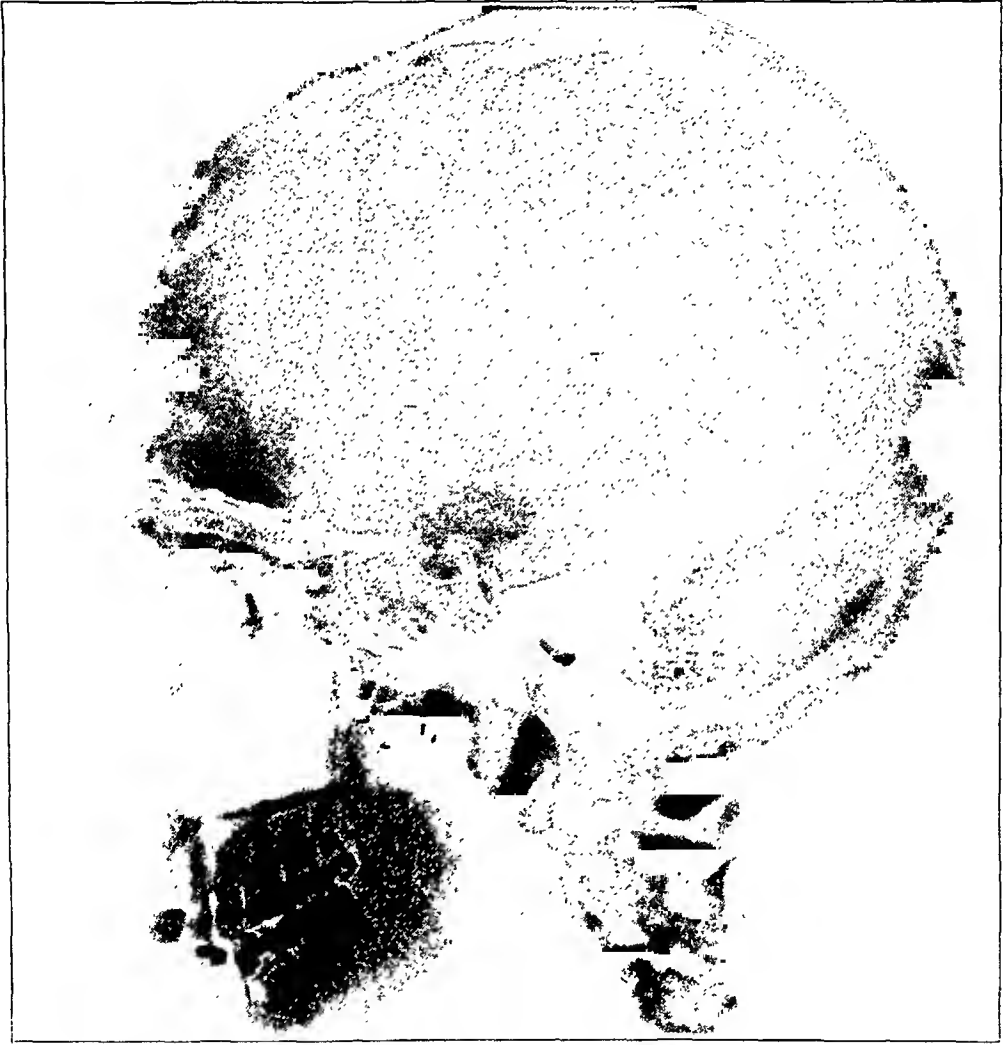


Fig. 6 (case 3).—Lateral roentgenogram showing radon seeds in situ.

Roentgenograms of the sinuses (Dr. H. Potter) were reported on as follows: "The principal finding is on a vertical view through the sphenoid region, where a large open space devoid of original bony elements is shown. This corresponds to about the proper position for the left sphenoid. The bony defect is at least  $1\frac{1}{2}$  inches (4 cm.) in width and nearly 2 inches (5 cm.) in anteroposterior direction. While bony elements are gone, this region contains the shadow of a soft mass which corresponds undoubtedly to the mass visible in the nasopharynx (fig. 4). The left frontal and ethmoid sinuses also are opaque, whereas the left antrum seems to be clear." Wassermann and Kahn tests on the blood were negative.

Biopsy of the tumor (S.A.F.) was reported on as follows: "In sections stained with hematoxylin and eosin an epithelial layer is not present, nor are there any apparent characteristics of mucous membrane of the respiratory tract. A dense cellular infiltration is in the nature of a compact connective tissue stroma, with the fibroblast as the predominant cell, interrupted by numerous capillaries and small blood vessels. Various stages of maturity of the fibroblasts may be recognized, the type most frequently encountered being an elongated spherical cell

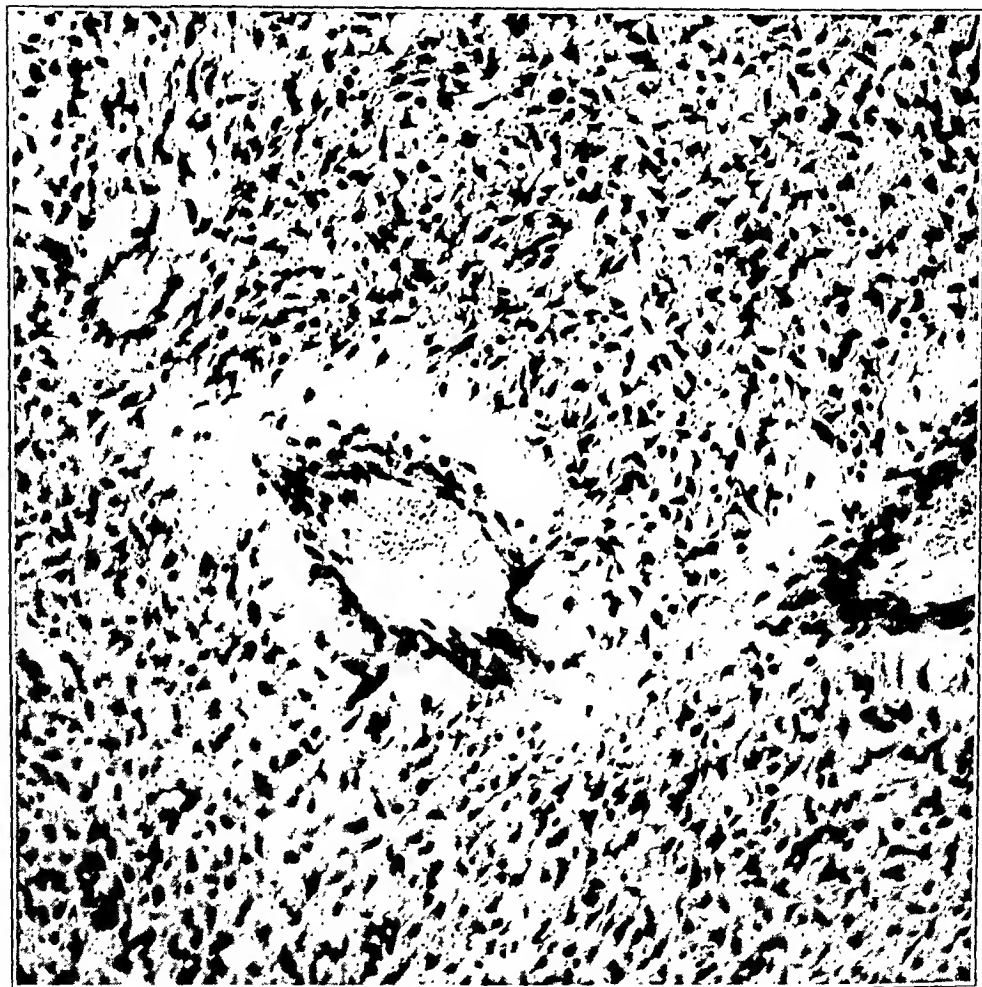


Fig. 7 (case 3).—Section of vascular fibroma illustrating involutional changes which either resulted from or coincided with irradiation. The perivascular thickening is marked.

with a moderate chromatin content. A nucleolus is evident in approximately 50 per cent of these cells. Next in frequency is an ovoid, rounded fibroblast with similar chromatin and nucleolar distribution. Only an occasional lymphocyte is evident. The vascular spaces are lined by endothelium and contain mostly erythrocytes, with an occasional polymorphonuclear leukocyte or monocyte. Perivascular changes or cellular reactions other than the fibroblastic activity described are not present (fig. 5)."

Between January 13 and March 31 the patient received 600 milligram hours of radium directly on the tumor within the nose and the nasopharynx. There was a resultant decrease in both size and vascularity of the growth. The spontaneous epistaxis had ceased after treatment was instituted and bleeding on manipulation had become progressively less marked.

On April 29 seven 1 millicurie radon seeds were implanted directly into the tumor via the nasopharynx. In June further roentgenograms showed the radon seeds in situ (fig. 6). In August, after submucous resection, the nasal fossa was almost completely clear save for synechia and a small mass overlying the middle turbinate far posteriorly. This seemed to communicate with the nasopharyngeal tumor, which had become relatively small in the vault of the pharynx. A portion



Fig. 8 (case 3).—Lateral roentgenogram showing retraction of the tumor and radon seeds toward the base of the skull. The figure should be compared with figure 6.

of the tumor was removed intranasally with surgical diathermy. There was some bleeding, and 10 radon seeds averaging 1 millicurie each were implanted into the nasopharynx via the nasal fossa.

Observations at biopsy at this time differed from those on the previous section in several respects: "The stroma is less compact and individual bundles of collagenous connective tissue may be easily distinguished, principally because edematous spaces produce wider separation of the cells. The fibroblasts exhibit less variation in size and shape, the majority having elongated nuclei with tapering cytoplasmic processes at their extremities. Plasma cells are present in increased number. There is definite thickening of the perivascular spaces in the form of a prominent fibroedematous zone surrounding each vessel. Traversing these zones

are occasional fibroblasts arranged in a radiating pattern (fig. 7). In sections of the same tissue stained with Mallory's aniline blue, the connective tissue stroma becomes accentuated, and erythrocytes filling the vascular spaces are brilliant red. Particularly prominent is the layer of perivascular connective tissue previously mentioned. In sections stained by the Foote method only a delicate reticulum formation is apparent."

In December a marked atrophic condition was noticeable in the left nasal fossa. Crusting was controlled with nasal irrigations. Lateral roentgenograms showed a marked retraction of the tumor and radon implantations toward the base of the skull (fig. 8). Vertical views through the sphenoid further illustrated the decrease of the growth. On mirror examination only a small reddened area was visible in the nasopharynx. This extended from the superior border of the torus tubarius medially along the upper choanal border into the posterior end of the septum. There was merely a slight fulness in this region and no actual tumor tissue. The sinuses were clear and the ears normal. A total of 600 milligram hours of radium and 2,250 millicurie hours of radon had been used.

In March 1939, the condition had not altered, and signs of recurrence were not present.

#### TREATMENT

Any perusal of the literature cannot but impress one with the importance of an accurate diagnosis and the desirability of rational therapy in dealing with this tumor, for it is not uncommon to find reports of deaths resulting from attempts at operative removal, although these have been less frequent in recent years. Extensive surgical resection involving the nose, palate or maxillas no longer has a place in the treatment of vascular growths. Avulsion with the cold snare should probably be abandoned because of the attendant hemorrhage and shock and the possible damage to the attached bones at the base of the skull, from the periosteal layers of which the growth may have arisen.<sup>7</sup> I have had no experience with attempts at reduction in the vascularity of the tumor by the injection of escharotics.

The use of radium was first suggested by Delavan<sup>1</sup> some years ago, and New and Figi<sup>8</sup> reported from the Mayo Clinic a series of cases in which this treatment was adopted. In these cases the radium was administered by holding lead applicators against the tumor, inserting needles or implanting radon. Roentgen rays also have been employed, either solely or in combination with radium.<sup>9</sup> More recently, surgical diathermy, alone or together with irradiation, has been proposed.<sup>10</sup>

7. Allan, F. G.: Nasopharyngeal Fibroma, *Arch. Otolaryng.* **19**:215-223 (Feb.) 1934.

8. New, G. B., and Figi, G.: *Am. J. Roentgenol.* **12**:340-342 (Oct.) 1924.

9. (a) Berven, E., and Heyman, J.: Report of Cases Radiologically Treated at Radiumhemmet, Stockholm, P. A. Norstedt & Sons, 1929. (b) Koch, J., and Eigler, G.: *Arch. f. Ohren-, Nasen- u. Kehlkopf.* **142**:1-14 (Oct.) 1937.

10. New, G. B., and Havens, F. Z.: *S. Clin. North America* **12**:939-945 (Aug.) 1932.

I believe that this combination, irradiation and surgical diathermy, offers by far the most satisfactory therapeutic approach. In general, it should be said that the type of treatment will depend somewhat on the age of the patient and the extent of the tumor. Radiation therapy may be regarded as the most effective means of reducing the extreme vascularity of the tissue and should probably be used as a preliminary measure in all instances. Since the growth rarely produces symptoms until it has reached considerable size, it is doubtful whether irradiation alone will suffice. (An exception may be found in the case of adults approaching the age of 25 to 30, when spontaneous involution sometimes occurs. In such a situation radiation may hasten the appearance of regressive changes.) The hemorrhagic propensity of the tumor having been materially reduced by radiation therapy, removal of the remaining portion may be most safely effected by surgical diathermy, with the opportunities thereby afforded for the control of any severe or troublesome bleeding. It appears that this routine entails less hazard than one in which the sequence of events is reversed, i. e., wherein initial removal by diathermy is followed by implantation of radon, as suggested by New and Havens.<sup>10</sup> In either event ligation of the external carotid or internal maxillary artery may be a valuable adjuvant.

Although it has been advocated that this tumor should be treated exclusively by irradiation,<sup>9a</sup> it must be recognized that complete disappearance of the growth would probably require a higher total dose than could be safely tolerated. The aim is therefore to initiate physiologic retrogression, but this cannot be depended on as a constant effect. Furthermore, the sensitivity of the nasal mucosa to irradiation is well known, and atrophic changes may result even from mild doses, as exemplified in the cases here reported. In addition, it is necessary to avoid radiation necrosis because of the danger of infection of the middle ear and osteomyelitis of the adjacent bones.

In the choice of various forms of radiation therapy I favor implantation of radon seeds into the tumor. As a preliminary measure it is often advisable to apply radium directly in the form of needles or with a well shielded applicator or to use roentgen rays or telerradium. In the cases presented, a striking reduction of troublesome bleeding rather rapidly followed the institution of irradiation. If the tumor is large, various portions may be treated effectively by implantation of radon and the damage to normal structures minimized. The average strength of each seed should be approximately 1 millicurie. Change in the position of the implants, as seen roentgenographically, provides further information as to the status of the growth.

After irradiation and the removal of the tumor by diathermy, any remnants or recurrences are readily amenable to treatment by further implantation of the radon seeds or electrocoagulation.



## SUMMARY AND CONCLUSIONS

The term "nasopharyngeal fibroma" is somewhat a misnomer and should, on histologic grounds, be modified. The designation of the tumor as "vascular fibroma" or "angiofibroma" is perhaps more appropriate.

Three cases are reported, in which treatment by a combination of irradiation and surgical diathermy has been successful.

An attempt was made to analyze the histologic alterations resulting from irradiation in these 3 cases. In 2, definite changes could not be observed in sections of tissue removed for study before and after treatment. In the third the alterations noted microscopically were a diminution in the compactness of the collagenous connective tissue bundles, maturation of fibroblasts, infiltration of plasma cells and definite fibroedematous perivascular zones producing an apparent thickening of the walls of the blood vessels. Because the patient had reached an age at which involutional changes might be expected, it is possible that therapy was the factor responsible for initiation of retrogressive changes, particularly since no evidence of such changes were apparent in the original biopsy taken seven months previously.

Despite the absence of significant histologic changes following irradiation in 2 of the 3 cases reported, a definite decrease in the vascularity of irradiated areas was noted clinically. This clinical alteration greatly facilitated subsequent removal of tumor tissue. The validity of this observation was borne out by an attempt to remove a recurrent tumor in the maxillary antrum. No irradiation had been used, and an almost uncontrollable hemorrhage resulted.

Because of the attachment of the tumor to the bones of the base of the skull and the involvement of these bones by pressure necrosis, it is suggested that avulsion with the cold snare should be abandoned.

The combination of irradiation and surgical diathermy offers a safe and effective method of treatment for vascular fibroma of the nasopharynx.

Drs. T. C. Galloway and L. T. Curry gave me the opportunity of studying the histologic specimens and the clinical records of the cases and permitted me to make this report.

122 South Michigan Avenue.

# INFECTION WITH ASPERGILLUS NIGER

## REPORT OF TWO CASES

LEON FELDERMAN, M.D.

PHILADELPHIA

The 2 cases to be reported in this paper tell the story of a disease which eludes detection through the ordinary method of examination. Diagnosis, then, is difficult and often at fault. Afterward, when the physician knows beyond peradventure that he has to deal with a fungous infection, the applied therapeusis becomes relatively simple. The diagnosis can be arrived at only through laboratory technic, and the germicide used must be selective.

Since Micheli,<sup>1</sup> 1729, described *Aspergillus* and named it because of its resemblance to "rough head," mycologists have identified nearly four hundred species of the family.<sup>2</sup>

In 1842, Benet established its pathogenicity for man, and the pathologist Virchow demonstrated it in the lungs post mortem.

Siebenmann<sup>3</sup> placed the proportion of aural infections due to *Aspergillus* at 1 per cent. The frequency of the infection in China earned for it the name of "Hong Kong ear." It is not uncommon in India and is listed as an occupational disease found in handlers of grain, hair sorters, workers with sponges and those who feed pigeons by placing the grain in their mouths.

## REPORT OF CASES

My patients both complained of pain accompanied by intolerable itching of the organs involved, nervous irritability, insomnia and headache.

CASE 1.—A housewife aged 33 was referred to the office with a provisional diagnosis of "impacted cerumen, bilateral." The family physician's diagnosis was accepted. The canals of the ears were freed from the impacted mass by washing. The membrana tympani was found to be congested and bulging in the vicinity of the Shrapnell zone, for which condition treatment was administered. In the

1. Micheli, F.: *Aspergillus capitulo pulla*, nova plantarum genera, 1729, p. 212.

2. Thom, C., and Church, M. B.: *The Aspergilli*, Baltimore, Williams & Wilkins Company, 1926, p. 168.

3. Siebenmann, F.: *Die Fadenpilze Aspergillus flavus, niger und fumigatus; Eurotium repens (und Aspergillus glaucus) und ihre Beziehung zu Otomycosis aspergillina*, Ztschr. f. Ohrenh. **12**:124-161, 1883; Wiesbaden, J. F. Bergmann, 1883.

course of five days, the patient returned with the external canals of the ears filled with the same substance. This time she complained of pain at the tip of the mastoid. On washing the canals of the ears, a greenish black wax was delivered, and at the end one could see a light greenish corkscrew form, which led to the suspicion of a fungous mass. The washings were immediately referred to the laboratory for study, and the report identified the organism as *Aspergillus niger*. Methylrosaniline, which had been used in the treatment, was replaced by an ointment of silver picrate, 10 per cent. After complete removal of the mass, the use of the ointment was continued, and the patient was kept under observation for a few months. As no recurrence of the mass in the ear was evident, she was discharged as cured.

CASE 2.—A woman aged 43, a cutter in a lace curtain factory, about a year ago complained of intense itching in the region of the nose, which was aggravated at night, causing insomnia. At the same time, her attention was drawn to the presence of a membrane in the interior of the nose, which not only filled the vestibule of the nose but extended to the lower edges of the middle turbinate. As the condition was bilateral, mouth breathing, with the attendant dry condition of the oronasopharynx, made speech hoarse and difficult. When the membranes were removed there remained a bleeding surface which reformed in about six or eight hours. The patient had visited five physicians at different times, and remedies prescribed had been of no avail. One physician made a diagnosis of "athlete's feet of the nose." At the time the patient consulted me the membrane was thick and of a distinct pinkish hue, obliterating the nasal passages. At first, the condition suggested pseudodiphtheritic membrane of a fungous growth. To reproduce the fungi in a proper culture (Sabouraud's medium) <sup>4</sup> was difficult. Cultures of material from the nose and throat were made, and the report from the laboratory was as follows:

"Microscopic examination of scabs from the nose on a preparation of sodium hydroxide did not reveal fungi. A Gram smear showed numerous epithelial cells and white blood cells and a few gram-positive diplococci. On Sabouraud's culture fungi were not isolated within seven days. Cultures of material from the nose revealed *Staphylococcus aureus*, *neisseria flavus* and *Bacillus coli*. The growth in Sabouraud's culture was of the *Aspergillus* type (identified by Dr. F. Weidmann)."

The composition of the culture medium used to reproduce the fungus follows:

"Sabouraud's conservation agar contains water, 1,000 cc.; peptone, 10 Gm., and agar, 18 Gm. For isolation and study of the organisms, Sabouraud's test agar, 1908, contains 40 Gm. of crude maltose."

Topical applications of methylrosaniline (5 per cent) found the membrane of the nose resistant, so that it was found expedient to change to local applications of an ointment of silver picrate (10 per cent), which produced an immediate improvement. The applications continued for several weeks. Since the membrane did not reform, the patient was discharged as cured.

It should be instructive and helpful to consider briefly the fungus responsible for this disease.

The *Aspergillaceae* <sup>5</sup> are a large family of fungi. They have a rapid, prolific and complicated system of growth. It is noteworthy that the

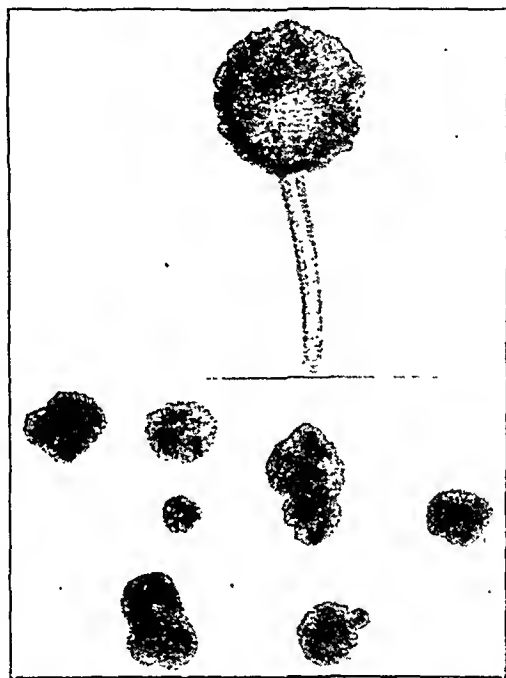
4. Dodge, C. W.: Medical Mycology, St. Louis, C. V. Mosby Company, 1935, p. 51.

5. Dodge,<sup>4</sup> p. 610.

periods of fertilization, flourishing and decline are swift, with the first two stages well developed before the host is aware of their presence.

Microscopically, they are recognized in many forms: Some are shaped like Irish lace; some resemble a sunburst; some are pelican shaped; some are flasklike, and some are shaped like umbrella sticks. There are various dimensions and sizes. The fungi may be bright or dull brown.

They are found in anemic plants which lack chlorophyll. This vegetative growth is ameboid. The ability which the fungi possess to reproduce themselves with ease is amazing, the two methods being fertilization and fusion of two nuclei.



*Aspergillus niger* heads (photographs by Mitchell L. Dratman, Thom and Church<sup>2</sup>); above, black, fairly regular head on a smooth stalk ( $\times 260$ ); below, organism in Petri dish, representing a globose head partially splitting.

Among some of the elements necessary for reproduction and growth are (a) water, (b) high humidity, (c) a carbon and nitrogen supply in suitable relation to the hydrogen ion concentration and (d) light.

The cases given in the literature on the subject of *A. niger* show that the regions most frequently infected are the ear, the nose, the mouth, the tongue and the lungs. This is not a complete list, but is sufficient to arouse the interest of the laryngologist and thus make him familiarize himself with a pathogenic organism which is increasingly common, undoubtedly largely because of the modern method of transportation. The automobile, the motor trailer and the aeroplane are the chief carriers of mycotic infections. It is interesting to note and should be

helpful in future diagnosing to remember that these infections have been mistaken for syphilis, tuberculosis, cancer, diphtheria and many other diseases.

One of the primary symptoms of fungous infection of the canal of the ear is dermatitis affecting the external auditory canal.<sup>6</sup> The examination discloses a red area with considerable shedding of the superficial layer due to intolerable itching. In cases of infection with *A. niger*, the accumulation of debris is rapid, with associated impairment of hearing.

There are fungi in addition to *A. niger* about which the practitioner knows but little. It will be informative to consider some of them because of the perplexing symptoms to which they give rise, which often lead to faulty diagnoses.

Jakowski,<sup>7</sup> as early as 1888, reported infection with *Absidia ramosa* in the human ear, an unknown mycotic infection. Since then the parasite has been successfully isolated from mucus of the upper air passages in the lower animals (cows, horses, swine).

*Aspergillus siebenmanni*<sup>8</sup> has been isolated from the human ear and apparently belongs to the *Aspergillus flavus* group but cannot be identified with certainty.

Macfie<sup>9</sup> reported an aspergillus which causes a mycotic infection of the ear with itching and irritation of the canal without affecting the hearing.

*Penicillium minimum*<sup>10</sup> is of interest because the fungus was isolated in a case of catarrh of the middle ear following scarlet fever. Three years later the organism was still present in a membrane, showing how resistant it is to ordinary germicidal treatment.

*Castellania copelli*<sup>11</sup> is found in lesions which appear on the tongue and has proved pathogenic to rabbits and guinea pigs.

*Mycoderma parargosum*<sup>12</sup> is found abundantly in sputum. The patient has a productive cough with mucopurulent expectoration. The advanced condition resembles phthisis; the patient is emaciated and has a hectic fever with bloody sputum. Yellowish gray patches in the

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6. Whalen, E. J.: Fungous Infections of the External Ear, *J. A. M. A.* **111**: 502-504 (Aug. 6) 1938.

7. Jakowski, cited by Dodge,<sup>4</sup> p. 113.

8. Lucet, A., and Constantin, J., cited by Dodge.<sup>4</sup>

9. Macfie, J. W. S.: Notes on Some Fungal Infections in West Africa, *Ann. Trop. Med.* **15**:279-281, 1921.

10. Dodge,<sup>4</sup> p. 641.

11. Dodge,<sup>4</sup> p. 252.

12. Dodge,<sup>4</sup> p. 219.

throat resemble those seen with diphtheria. Physical examination adds to the confirmation, but a microscopic examination of the fungus rules out pulmonary tuberculosis.

*Candida bethaliensis*<sup>13</sup> is another form of parasite invading pulmonary tissue, causing symptoms resembling those of tuberculosis. It was isolated from the sputum of a patient who suffered from cough, leukocytosis, febrile attacks and hemorrhages.

*Pseudomonilia allesandrina*<sup>14</sup> also is isolated from mucopurulent sputum in cases of bronchitis.

Mekundu<sup>15</sup> has been isolated from sputum in cases of bronchitis in inhabitants of Belgian Congo. A history of malaria, bronchitis and fever at first suggested undulant fever.

#### CONCLUSIONS

1. Aspergillosis of the upper air passages must occur with greater frequency in North America than the reports in the literature indicate.

2. Modern methods of transportation introduce molds and fungi from distant countries.

3. The growth of fungi in certain culture mediums is relatively slow, and one must allow a few weeks before the mold can be reproduced.

4. Silver picrate ointment has fungicidal properties and proved efficacious in the 2 cases reported.

Central Medical Building, 1737 Chestnut Street.

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13. Dodge,<sup>4</sup> p. 229

14. Dodge,<sup>4</sup> p. 295.

15. Dodge,<sup>4</sup> p. 350.

## Case Reports

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### EXPULSION OF FOREIGN BODY FROM THE ANTRUM WITH THE AID OF IRRIGATION

E. R. HARGETT, M.D., SPRINGFIELD, OHIO

Recently I have successfully employed irrigation by means of a trocar in a series of cases of infection of the antrum following extraction. The patients did not have a history of any foreign body having entered the antrum, although a few of them had fistulas. Treatment was started soon after the dental work had been done. Roentgenograms of the antrum were not taken in the majority of the cases. The following case is cited as unusual in the series:

A 26 year old nurse presented herself at my office complaining of pain in the left cheek, aching in the small joints of the hands and feet and general malaise. Nine days previously, the upper left third molar had been extracted. The present illness began two or three days later. It was recalled that a small piece of gauze had been left in the cavity by the operator and had not been recovered, supposedly having been swallowed or expectorated.

Examination revealed a healed extraction cavity and findings leading to a diagnosis of empyema of the left antrum. A quantity of green, foul-smelling pus was removed by irrigation, with relief from the local pain and general symptoms the next day. Several more irrigations were carried out at two day intervals. The day after the fifth irrigation the patient became conscious of a mass high in the left nostril. After a few minutes of blowing her nose she obtained a small piece of gauze from the left nostril. She brought this specimen to the office. It was 0.5 cm. wide and 2 cm. long, a typical small piece of dental packing. Within a few days the antral washings returned clear and she was discharged as cured.

According to the dental operator, a fragment of root was not left in the cavity and the tooth came out cleanly. It is interesting to note that the foreign body would not have shown on roentgenograms. Although the gauze may have been carried to the natural ostium by the irrigations, it apparently did not come out directly at the time of the washing but was carried through by ciliary motion in the presence of severe infection. Another unusual point in the case is that, although there was a large perforation into the antrum, with a foreign body and empyema, a fistula did not form.

First National Bank Building.

## PAGET'S DISEASE OF THE BONES OF THE SKULL WITH OBLITERATION OF THE SINUSES

JOHN H. CHILDREY, M.D., SAN FRANCISCO

Paget's disease, or osteitis deformans, first described in 1877, is a disease of unknown cause, usually affecting a number of bones and occurring in patients over 40 years of age. It may be <sup>1</sup> a general disorder in which at present only the osseous changes are known. Formerly considered rare, it is known to be merely unusual, and with more roentgenograms the disease, no doubt, will be recognized oftener, particularly in its earlier stages. Osteitis deformans affects especially the skull, vertebrae and bones of the leg although it may be confined to one bone. The sacrum, spinal column, femur and cranium are oftenest affected,<sup>2</sup> but the disease may commence in the skull or maxilla.

Although the cause is unknown, it is thought by some that the disease has a vascular origin (endarteritis), possibly embolic, so closely do the lesions resemble the distribution of carcinomatous metastases in bone. Others, because of the similarity of the histologic picture, which is one of rarefaction of osseous tissue and its replacement by young, actively growing fibrous tissue, think that osteitis fibrosa, osteitis deformans and osteomalacia are one condition, differing only in the age and vitality of the patient. It has been shown in some cases that the sclerotic lesions of Paget's disease developed in a few years about the osteoporotic lesions of osteoporosis circumscripta of the skull, and some believe the latter to be the absorptive phase of Paget's disease or at least a related precursor, although Paget's disease affects the vault (fig. 2) while the other condition usually begins in the frontal and occipital bones near the base (fig. 1 B). Sosman<sup>3</sup> mentioned a patient who improved considerably under roentgen treatment of the parathyroid glands. However, with Paget's disease, unlike the situation with osteitis fibrosa, the patients are older; formation of bone has outstripped its destruction; there is no accompanying hyperparathyroidism; the values for calcium and phosphorus in the blood are normal, and there is no parathyroid hyperplasia. The concentration of phosphatase in the serum, normally 1 to 5 units (Bodansky) per hundred cubic centimeters, may in

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1. Moore, in discussion on Kasabach, H. H., and Gutman, A. B.: Osteoporosis Circumscripcta of the Skull and Paget's Disease: Fifteen New Cases and a Review of the Literature, *Am. J. Roentgenol.* **37**:577-602 (May) 1937.

2. Schmorl, G.: Ueber Ostitis deformans Paget, *Virchows Arch. f. path. Anat.* **283**:694, 1932; cited by Boyd,<sup>4</sup> p. 978.

3. Sosman, in discussion on Kasabach, H. H., and Gutman, A. B.: Osteoporosis Circumscripcta of the Skull and Paget's Disease: Fifteen New Cases and a Review of the Literature, *Am. J. Roentgenol.* **37**:577-602 (May) 1937.



severe Paget's disease be increased to 30 or 40 units. However, Boyd<sup>4</sup> stated the objection to such comparisons that replacement of fibrous tissue is not a specific lesion but is observed in a variety of osseous bone diseases.

Osteitis deformans begins with softening, at which time the affected bone is often painful, and continues with overgrowth of the bone. During the softening, characteristic deformities occur, and when the skull is affected it may become much thickened and enlarged. The face usually is not involved, but occasionally the facial bones become much thickened, giving the appearance of leontiasis ossea (fig. 3 *A*), and the maxilla may become so large that the maxillary teeth telescope over the lower teeth when the mouth is closed<sup>5</sup> (fig. 3 *B*). Deformities of vertebral bones may result in spinal curvature, while those in the long bones of the extremities result in thickening and bowing, so that the figure is shortened. Although progressive, the disease usually is not fatal. However, arteriosclerosis is often marked; fractures and pseudofractures may occur, and there is a tendency toward the development of osteogenic sarcoma.

The roentgen picture is characteristic, even before any deformity has appeared, but it varies with the phase in which the disease is seen. After the stage of primary softening, in which bone is replaced by connective tissue (fig. 2), the bone becomes hard and thicker, for ossification predominates, and there is a heavy deposit of subperiosteal finely porous cancellous bone on the long bones and on the skull, making the surfaces rough and irregular (fig. 4 *A*). The affected bones are thick and dense, although the medullary cavity is widened. The vault of the skull presents a peculiar serrated appearance (fig. 4 *A*). There is a complete metamorphosis, for the normal structure disappears and new bone is laid down on a massive scale (fig. 1 *A* and *C*).

Two of the most interesting features of the microscopic picture are the great number and the irregular arrangement of the lamellar systems, individual in appearance and having what is known as a mosaic structure due to variously shaped areas of new and old bone separated by ground substances.<sup>4</sup> The medullary cavity is filled with fibrous tissue.

The differential diagnosis should present no difficulty, for the various conditions from which the disease is to be distinguished in the osteoporotic stage, such as cholesteatoma, mucocoele, hyperparathyroidism, gumma and various tumors and their metastases, are characterized by destruction of bone, while in Paget's disease, as in osteoporosis circumscripta, decalcification alone occurs and the architecture of the bone remains intact.

The sclerotic lesions of Paget's disease may be confused with healed tuberculous lesions and also must be differentiated from hyperostoses, syphilitic osteitis and Albers-Schönberg disease. The last occurs in childhood.

4. Boyd, W.: A Textbook of Pathology, ed. 2, Philadelphia, Lea & Febiger, 1934, pp. 970-972.

5. Stafne, E. C., and Austin, L. T.: A Study of Dental Roentgenograms in Cases of Paget's Disease (Osteitis Deformans), Osteitis Fibrosa Cystica and Osteoma, J. Am. Dent. A. 25:1202-1214 (Aug.) 1938.

## REPORT OF CASES

CASE 1.—R. L. P., a man aged 24, came for an examination on Oct. 16, 1937, because he believed the glasses he was wearing were not improving the poor vision of his left eye, which he had noticed for many years. This eye seemed to him to have been on a higher level than the right for as long as he could recall. His face was markedly asymmetric, with considerable bulging of the forehead, a condition he attributed to a forceps delivery at birth. He stated that he was not born until some days after labor normally should have occurred and that five days after the membranes ruptured a prolonged delivery with forceps was done. He

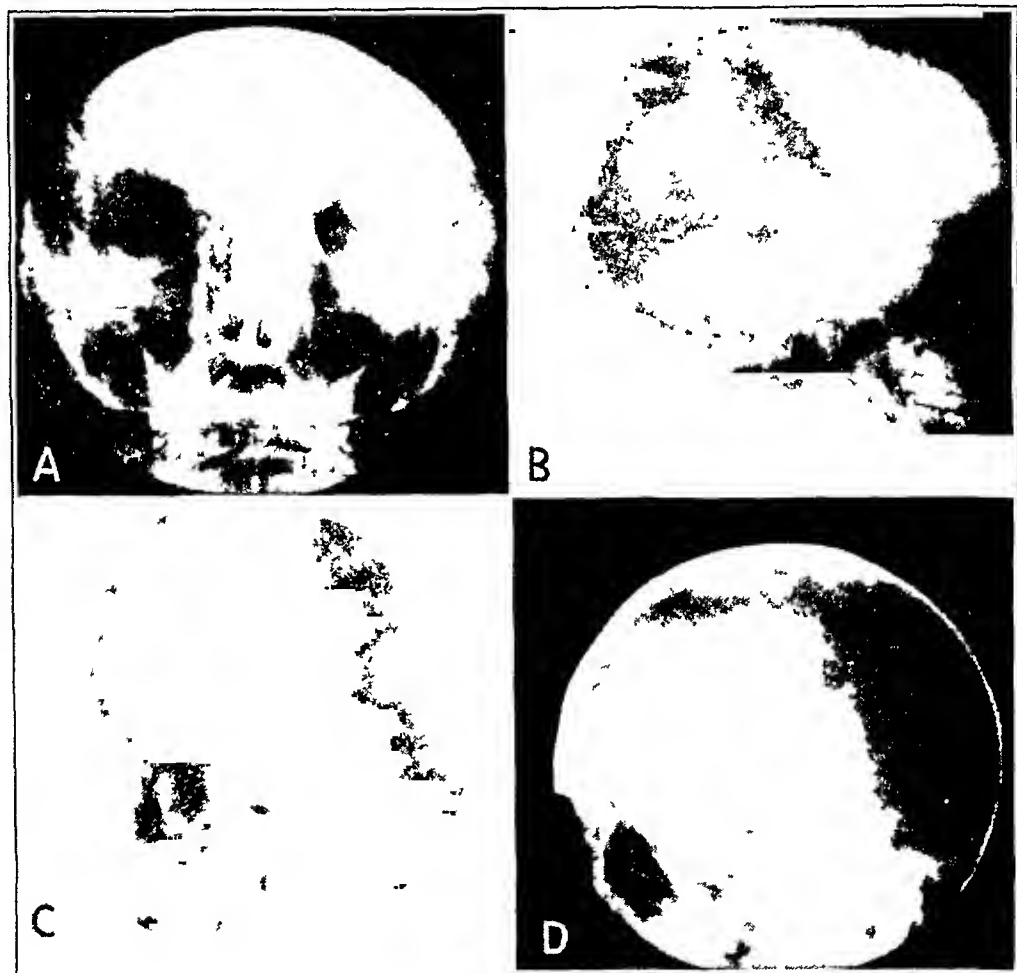


Fig. 1 (case 1).—Extensive involvement of the maxilla and the sphenoid and frontal bones. Note the narrowing of the optic foramina and the almost complete obliteration of the frontal, ethmoid and sphenoid sinuses.

was found to be considerably myopic, but with correction his vision was 100 per cent in the right eye and 70 per cent in the left. It was felt that the refractive error did not explain the impaired vision in the left eye. The media and the fundi were normal. The left eye was 12 mm. above the plane of the right (fig. 1 A). Studies done with a perimeter at this time and three months later gave essentially the same results and showed slight contraction of the temporal fields.

Examination of the ear, nose and throat gave essentially negative results. Roentgenograms of the skull showed marked hyperostosis and sclerosis of the bones of the anterior and middle fossae, with great thickening of the bones of

the supraorbital region (fig. 1 *B*). There was involvement of the horizontal frontal plate and increased density of the ethmoid labyrinth, and the sphenoid was solid bone with no evidence of a sinus. The optic foramina were both smaller than normal because the surrounding sphenoid bone encroached on them (fig. 1 *C* and *D*). Involvement of the bones was more marked on the left side of the head, there being apparently no left frontal sinus and little, if any, air space in the left ethmoid labyrinth, and the floor of the nose was lower on the left side than on the right (fig. 1 *A*). The cranium was involved as high as the vertex. The Wassermann and Kahn reactions of the blood were negative; the urinalysis gave normal results; the blood pressure was 134 systolic and 69 diastolic, and physical examination showed no other abnormality, revealing no apparent involvement of other parts of the skeleton.

The striking osseous changes were probably the cause of the signs of involvement of the eye. In this case the location of the lesion, that is, in the frontal bone primarily, near the base, and the age of the patient, only 24, both favored the diagnosis of osteoporosis circumscripta. In fact, the disease in this case had been



Fig. 2 (case 2).—Early stage of Paget's disease. The lesion is limited to the vertex.

present many years and must have begun in childhood. However, the roentgen appearance was characteristic of osteitis deformans, for there were both osteoporosis and sclerosis. Such a case lends support to the belief that the two conditions are interrelated. It seems questionable whether the trauma of childbirth was of etiologic importance. Noteworthy is the deformity of the skull and its consequences, namely, obliteration of the air spaces of the sinuses or failure of their development and the narrowed optic foramina. As remarkable, though not unusual, is the lack of discomfort.

**CASE 2.**—Mrs. J. V., a woman aged 45, came in June 1931 for an examination of her eyes, the vision of the left eye being limited to ability to see fingers at 2 feet (61 cm.) and that of the right being 30 per cent, because of bilateral posterior staphylomas and changes in the macular regions. The media and the fundi were normal. The perimeter showed the fields to be irregular, bilaterally contracted with central blurring on the left. The tangent screen bilaterally gave the impression of bitemporal defects. Roentgenograms of the teeth and sinuses were normal, but those of the skull showed thickening of the calvarium, most marked in the parietal bones, characteristic of Paget's disease (fig. 2).

Ten years previously a large posterior staphyloma had been found in the left eye. Studies of the visual fields at that time showed a central scotoma on the right, and the vision of the right eye was 4.5/20 and that of the left eye 4.5/75.

The vision of the left eye continued to fail, and early in 1932 it was 3 per cent. The patient returned in 1935 because of severe dizziness of several weeks' duration, which was diagnosed as subsiding toxic irritation of the right labyrinth. Some six months earlier she had undergone an extensive gynecologic operation, complicated by thrombophlebitis in the right thigh. The vision was now 60 per cent in the right eye and 33 per cent in the left. The media and the fundi were as before except for the presence of many glistening floaters. Unfortunately no more roentgenograms were made.

CASE 3.—Mrs. M. M. W., a woman aged 59, came to the hospital on Jan. 30, 1937, because of failing vision in both eyes noticed for a year and associated with occasional shooting pains in the eyes. She wished glasses, if advisable. She presented a strange appearance; she was short and squat; her back was bent and

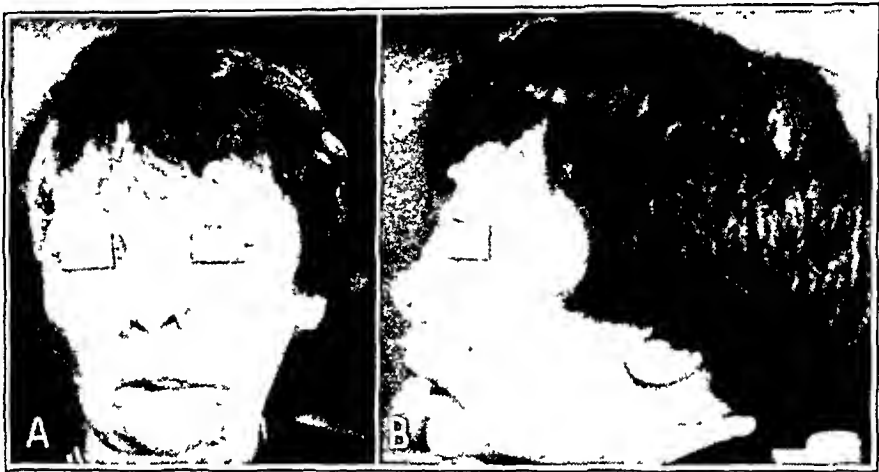


Fig. 3 (case 3).—Photograph of the patient, showing extensive involvement of all the bones of the skull. The mandible is not affected.

the shoulders sagged. She did not wear a hat; her head was large, as was the upper portion of the face, so that both gave her a leonine appearance (fig. 3). Vision in the right eye was 5 per cent, and that in the left 10 per cent, of normal. Examination of the eyes with the aid of eucatropine hydrochloride anesthesia showed the lens to contain slight diffuse and peripheral opacities, more marked nasally and below and more marked in the left eye. There were marked temporal pallor and depression of the optic disks, white patches and degenerative changes in the macular regions and evidence of scattered hemorrhages. On refraction slight hyperopic astigmatism was found, and little improvement of vision was obtainable in the right eye with correcting lenses. The intraocular tension was 40 in the right and 52 in the left eye. Charts made with the perimeter showed marked bilateral contraction of the visual fields. Charting with the tangent screen was impossible because of the poor vision.

Roentgenograms of the skull showed thickening and a generalized wooly appearance of all bones except the mandible (fig. 4); the nasal accessory sinuses were obliterated, as were the mastoid air cells, and the upper cervical vertebrae were

involved as well. There were numerous deposits of dense sclerotic bone throughout. Roentgenograms of the spine, pelvis and most of the long bones confirmed the diagnosis of advanced Paget's disease.

Ethylmorphine hydrochloride and pilocarpine hydrochloride were advised for use in the eyes at home. Six months later vision had continued to fail and hearing became impaired. At this time she began having dull and at times severe pains with swelling in the arms, and pain in the back made walking impossible. The pain became more persistent and severe, so that opiates became necessary. In October,

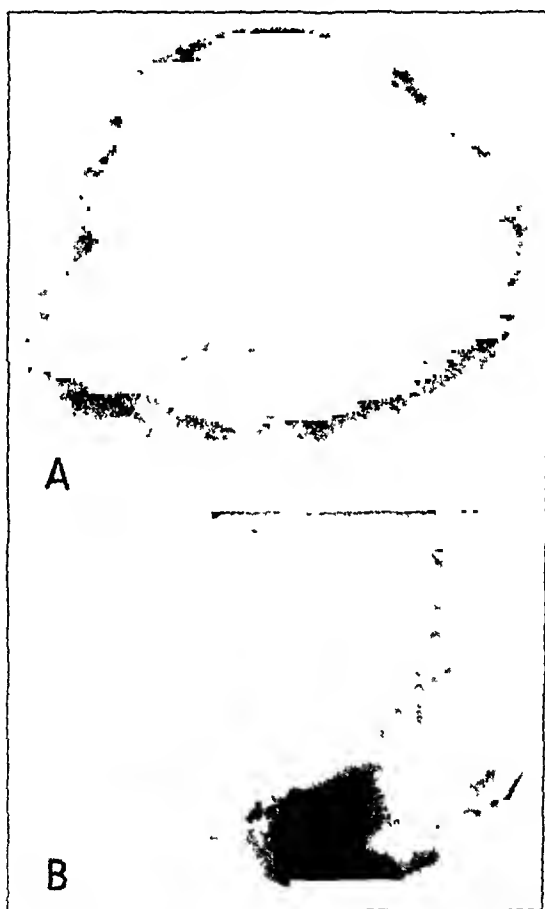


Fig. 4 (case 3).—Advanced Paget's disease of the skull. The air spaces of the sinuses and mastoid are obliterated.

the thighs became anesthetic; the right knee swelled, and the right arm was so swollen and weak that she could not lift the hand. The cheek bones became more prominent; the chin seemed more pointed, and large swellings appeared on the skull. Her mind remained clear. She died on November 19. An autopsy was not performed, but from the history it is suspected that osteogenic sarcoma was the cause of death.

Greens' Eye Hospital.

# Clinical Notes; New Instruments and Technics

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## CORRECTION OF SADDLEBACK DEFORMITIES OF THE NOSE BY SPECIALLY CUT CARTILAGE FROM THE EAR

F. HARBERT, M.D., PHILADELPHIA

The most common causes of saddleback deformities are abscess of the septum, too complete a submucous resection, trauma and some congenital anomalies. There is a growing and justifiable tendency to correct more moderate deformities, especially for persons in whom they cause a feeling of inferiority; but until recently only the more extreme deformities were routinely operated on. Beck and Guttman<sup>1</sup> cautioned against operating on patients who are psychically unstable or in whom the psychic disturbance is out of proportion to a minor defect, lest the operative procedure serve as a basis for a new obsession.

The saddleback nose is one of the easiest and most satisfactory of deformities to correct. The methods and materials are varied, however. Inert transplants, such as paraffin, gold, silver, celluloid and ivory, have been practically abandoned, although there are still some staunch advocates of the use of ivory.<sup>2</sup> The main objections are the rigidity of these materials and their tendency to be expelled. Bone transplants have likewise been abandoned, because they are too easily absorbed. Rib cartilage has the advantage of being available in large quantities, but its tendency to curl often changes a fine initial result into a caricature. When large defects are to be corrected this chance must be taken, however. Septal cartilage has the disadvantage of being absorbed either wholly or in part, so that the final result is unpredictable. Recently the use of cartilage preserved in aqueous solution of merthiolate has become increasingly popular, because the percentage of takes compares favorably with that when living tissues are used.

The advantages of auricular cartilage over all other transplants are its flexibility, its permanence in size and shape when transplanted and its subsequent growth as a living integral part of the body. Another advantage is the complete regeneration of cartilage at the site of removal from the ear. This takes place in from six to twelve months. When cartilage from the ear is utilized, strips are usually cut and inserted until the desired effect is produced, or strips are sewn together with catgut to form a single graft suitable for the defect. The objection to these methods is that the pieces tend to slip with the former and that the amount of flat cartilage suitable for building up a graft is limited with the latter. In fact, the greatest objection to the use of cartilage from the ear is the small amount available.

The object of this paper is to propose a method of cutting the cartilage which takes full advantage of the thickest part of the cartilage and produces a single piece of grafting cartilage admirably adapted to fill the usual saddle nose defect. This method has been used with gratifying results, and, as will be seen, the technic is simple.

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The opinions and assertions contained herein are the personal ones of the writer and are not to be construed as official or as reflecting the views of the Navy Department or of the Naval Service at large.

1. Beck, J. C., and Guttman, M. R.: Recent Advances in Plastic and Reconstructive Surgery of the Ear, Nose and Throat, *Am. J. M. Sc.* **196**:875, 1938.

2. Wolf, G. D.: Correction of Saddle Nose, *Arch. Otolaryng.* **22**:304 (Sept.) 1935.



Fig. 1.—Above, front and side views of patient with congenital saddleback deformity. Below, front and side views of same patient three months after operation according to the technic described here.

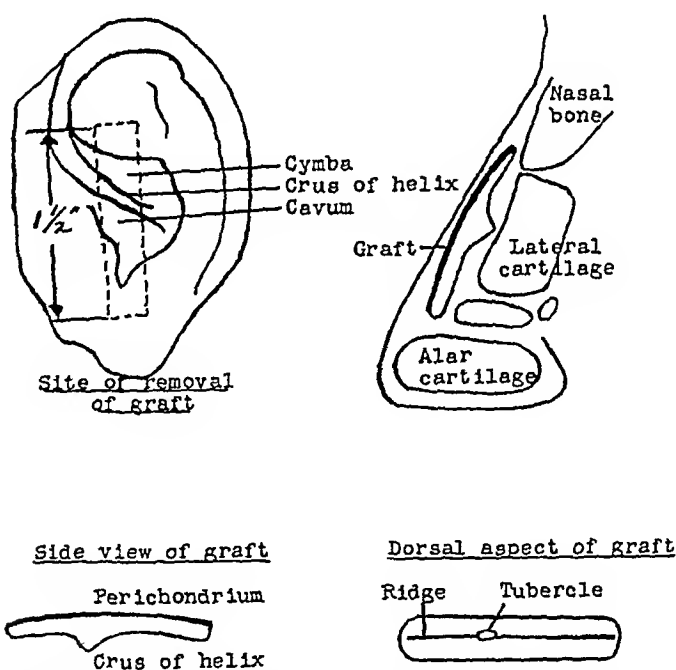


Fig. 2.—Schematic drawing showing graft of cartilage from the ear and its relations when transplanted into the nose

With the area under anesthesia produced by infiltration of 1 per cent procaine hydrochloride and epinephrine hydrochloride, a long incision is made in the crease at the junction of the ear and the scalp. The skin over the dorsal aspect of the pinna is elevated, with exposure of the perichondrium. The elevation should proceed until the vertical ridge on the dorsal aspect of the cartilage and its tubercle lie in the middle of the operative wound but are still covered by perichondrium. A strip of cartilage is then outlined with a Freer or a Bard-Parker knife, about  $\frac{3}{8}$  inch (1 cm.) in diameter and about  $1\frac{1}{2}$  inch (3.8 cm.) long, with the vertical ridge extending downward from the tubercle exactly in the middle of the strip. The crus of the helix should be near the middle of the ventral aspect. The incision is made down to but not through the perichondrium on the anterior aspect of the concha and the strip elevated with a submucous elevator, the anterior perichondrium being left intact. The excised strip with attached dorsal perichondrium is now trimmed to the shape shown in the diagram and to a size suitable for the defect to be corrected.

The nose is prepared for the reception of the graft by tunneling over the dorsum through an incision in the gap between the lateral and the alar cartilages. The nasal injection of procaine hydrochloride should be kept to a minimum in order to avoid distortion of landmarks and to permit accurate correction of the defect. Too wide a tunnel should be avoided in order to keep the graft from slipping. When the graft is inserted it is apparent that the crus of the helix greatly helps to fill in the central defect without adding to the weight and thickness of the graft. The convex curve of the dorsal perichondrial surface prevents the ends of the graft from projecting through the skin, and the ridge on this surface produces a sharp nasal bridge. The tubercle and the undesirable bumps have, of course, been trimmed off before insertion of the cartilage. The incision is closed by a single suture, and a wide piece of adhesive plaster over the dorsum of the nose completes the nasal dressing. It is well to close the incision in the ear last in order to permit the procurement of additional cartilage should it be required. The incision is nicely closed with vertical mattress sutures and a mastoid dressing applied after the cavum conchae has been filled with cotton, which produces a firm and continuous pressure and prevents the formation of hematoma. Except for slight postoperative swelling, lasting a few days, convalescence is uneventful, and infection has not been encountered.

United States Naval Hospital.

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## CORRECTION OF LATERAL DISPLACEMENT OF FREE BORDER OF THE SEPTAL CARTILAGE

F. HARBERT, M.D., PHILADELPHIA

Lateral displacement of the free border of the septal cartilage is a common finding in any clinic where many submucous resections are performed. This displacement produces:

1. Protrusion of the free border of the septal cartilage in one nostril instead of lying between the cutaneous surfaces of the columella.
2. Displacement of the inferior edge of the septal cartilage lateral to and below the anterior inferior nasal spine and the groove of the vomer, allowing the tip of the nose to drop.

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The opinions and assertions contained in this report are personal ones of the writer and are not to be construed as official or as reflecting the views of the Navy Department or of the Naval Service at large.

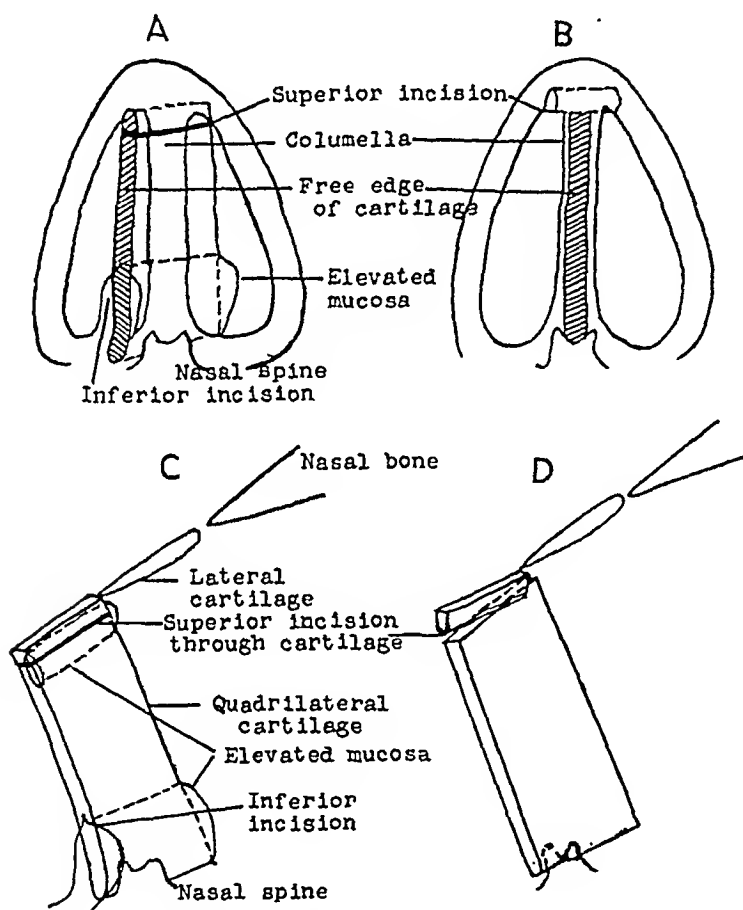


3. Pulling of the columella to the side of the protruding cartilage and enlargement of the opposite nostril.

4. Curling of the septal cartilage with the concavity on the side of the protruding edge. Usually the curling is sufficient to cause obstruction on the opposite side because of the convex bulge.

A classic submucous resection in such cases will obviously not relieve nasal obstruction.

Various methods of replacing the cartilage without submucous resection, of which the methods of Metzenbaum and Cohen are examples, have been advocated.



*A*, view of the nares showing the free edges of the quadrilateral cartilage displaced in the right naris. The lower margin of the cartilage lies lateral to and below the nasal spine. *B*, view of the nares showing the replacement of the free edge of the cartilage within the columella, the lower margin resting in the groove of the nasal spine. The upper strip of cartilage remains deviated. *C*, side view of the strip of quadrilateral cartilage remaining after submucous resection. The mucosa has been elevated along the inferior margin and near the carina nasi. Through the upper mucosal incision the cartilage is incised, leaving a narrow strip above and the lower segment freely movable. *D*, side view of the strip of quadrilateral cartilage after the replacement of the lower margin in the groove of the nasal spine showing the rotation of the lower segment on the upper strip.

These are probably excellent for children, in whom submucous resection may interfere with subsequent development of the nose. In the adult presenting this picture, however, the septum will usually have secondary deviations producing the classic S-shaped deformity, ridges and spurs which require submucous resection to restore the airway.

Such an expedient as excising the protruding edge has the objection of not correcting the depressed tip but instead further removing support for it. Moreover, it will not correct the obstruction caused by the convex bulge in the opposite nostril. Peer<sup>1</sup> advocated complete excision of the deviated and dislocated quadrilateral cartilage and inserted a support from a straight piece of this cartilage. In cases in which the anterior segment of the cartilage is hopelessly deformed and thickened, this is probably the method of choice. Fortunately, the majority of these dislocations leave the cartilage intact except for smooth curves of deformity and make them particularly amenable to correction by the simple procedure advocated here.

A classic submucous resection is performed first and complete healing permitted. Usually a month suffices, but the procedure is equally applicable years after the original submucous resection. With the area under anesthesia produced by infiltration of 1 per cent procaine hydrochloride and epinephrine hydrochloride a small vertical incision, about  $\frac{3}{8}$  inch (1 cm.) long, is made over the lowermost aspect of the protruding septal tip. The mucosa is elevated on both sides of the cartilaginous strip to its posterior extremity, the lower  $\frac{3}{8}$  inch of the strip and its inferior edge thus being exposed.

Through the same incision, the groove in the anterior inferior nasal spine is deepened by incisions and if necessary by excisions with the Freer knife. It will now be found that the lower part of the septal cartilaginous strip is freely movable. If not sufficiently mobile, it can be made so by elevating the mucosa slightly higher. In some cases the cartilage can now be lifted into the groove of the anterior nasal spine, and the cosmetic and functional result will be good. Usually, however, the upper attachment of the cartilage will produce tension and tend to cause recurrence of the subluxation, or the upper portion of the free border of the cartilage will still protrude. In such cases an incision about  $\frac{1}{4}$  inch (0.6 cm.) long is made at the junction of the septal cartilage and the carina nasi. The entire junction is exposed by elevating the mucosa on one side only with a septal elevator, through a channel as narrow as possible. A Freer knife is now introduced through this channel and the septal cartilage incised down to but not through the mucosa of the opposite side. Lateral movements of the entire septal strip are now easy, because it remains attached only to the mucosa in its middle portion on both sides. The strip is placed in position in the groove of the nasal spine, and it will be found that there is no tension and no tendency for slipping. The proper position of the strip is maintained by splints of dental wax and/or light gauze packing. Its vitality is assured because of extensive attachments of mucoperichondrium remaining.

There are usually slight postoperative swelling and thickening of the columella when the packing is removed twenty-four hours later, and this persists for about a week or more. It is surprising how the redundancy of mucosa, which is often noticeable at first, disappears in the course of a few weeks, leaving an excellent cosmetic and functional result.

United States Naval Hospital.

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1. Peer, L. A.: An Operation to Repair Lateral Displacement of the Lower Border of the Septal Cartilage, *Arch. Otolaryng.* **25**:475 (April) 1937.

# Progress in Otolaryngology

Summaries of the Bibliographic Material Available in the  
Field of Otolaryngology.

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## FUNCTIONAL EXAMINATION OF HEARING

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AND

NORMAN LESHIN, M.D.

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The literature of the past year contains a relatively small contribution on the functional examination of hearing. Hardly any new tests or practical variations of the old ones have been published. Audiometry is used to a greater extent in the testing. The few articles found in the foreign literature show definite activity in this field. Interest in the testing of school children and in the interpretation of results is evident. Considerable attention is being given to hearing aids and their development and use.

Holmgren<sup>1</sup> has written a complete monograph on hearing tests and hearing aids. He reviews the procedures, evaluates the criticisms and gives his own views obtained from investigations carried out in the otorhinolaryngologic clinic, Sabbatsberg Hospital, Stockholm. He traces the development of hearing tests and hearing aids and presents the fundamental acoustic principles and their relation to speech and hearing. One cannot ascribe any great value to comparative auditory examinations unless they are conducted in a sound-proof room or under identical conditions of noise. Papers dealing with results of hearing tests with no information on the acoustic conditions under which the results were obtained cannot be given serious consideration in a scientific discussion. Holmgren discusses the practical value of conversation and whispering tests and tuning fork tests from an acoustic standpoint. He describes the construction of an electrically activated tuning fork to be used for obtaining the most reliable values for hearing by bone conduction. Bone conduction tests with tuning forks should be done not only with forks of 128 double vibrations but also with those of higher pitch, up to 1024 double vibrations. The value for hearing by bone conduction obtained with 128 double vibrations represents a functional test of the cochlea for this frequency only.

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1. Holmgren, L.: *Hearing Tests and Hearing Aids*, Acta oto-laryng., 1939, supp. 34, p. 1.

A critical survey of the prevalent construction of audiometers is made and the possible sources of error discussed. Holmgren presents the advantages of the loud speaker used on the audiometer employed in his clinic as compared with the receiver placed against the ear. Values for the air conduction are obtained without any additional effect from the bone conduction. The loud speaker gives exact intensity at the same distance from the ear, while the intensity from the receiver varies considerably if it is pressed with varying firmness against the ear. There are no variations for resonance and no variations in the threshold caused by different dimensions of the auditory canal and the outer ear with the loud speaker as contrasted with the receiver. Measurements made with the loud speaker of the sound-amplifying effect of hearing aids are made under acoustic conditions identical with those under which they are intended to be used. The receiver, on the other hand, is more easily portable and less expensive and conducts less sound to the other ear. In comparing tuning forks with the audiometer, Holmgren concludes that with the exception of the measurement of frequencies of 32 and possibly 64 double vibrations the audiometer yields more complete, more reliable and speedier results than the tuning forks. This takes into consideration, however, an audiometer furnished with thoroughly correct and trustworthy measuring instruments. Since in dealing with a complicated electrical instrument the possibilities or sources of error are always present and have to be considered, he advises the control of audiometric readings by means of some simple tuning fork tests.

Holmgren presents, further, a critical survey of hearing aids, their description, the ways and means for prescribing and testing them and the benefits that can be obtained for persons with the different types of impairment. He brings out the difficulty of compensating perceptive loss of hearing due to the "recruitment phenomenon." The superiority of the tube amplifier in comparison with other constructions is emphasized. The principal dissimilarities between loss of hearing of the conductive and that of the perceptive type are as follows: In the conductive type, the lower tones and the intelligibility of the vowels alone are affected; perception of speech is considerably weakened, though it sounds clear and is understandable even with relatively great loss of hearing; the intelligibility slowly decreases with increased distance from the source of sound, and weak tones and noise are not heard at all; suitable hearing aids are easily procurable with the amplification arranged so as to shift the audition curve parallel upward toward the normal; the qualitative intelligibility of speech is not changed with amplification. In loss of hearing of the perceptive type, the higher tones and the intelligibility of consonants alone are affected; the perception of speech is not weakened to any great extent, but it appears indistinct and is appreciated with

difficulty even with loss of hearing for a relatively small range of tones; the intelligibility decreases quickly with increased distance from the source of sound, but weak tones and noise of low frequencies can still be heard—the patient has to make a great effort to interpret what he hears; hearing aids can be fitted only with great difficulty even with the use of tube amplifiers, and the amplification is best arranged in a selective manner corresponding with the loss curve, the recruitment phenomenon with regard to the same being taken into consideration; the amplified sound seems qualitatively changed, and adaptation to the degree of selective amplification which gives the best intelligibility must take place successively. Holmgren emphasizes especially the characteristic of perceptive deafness that speech is heard distorted even though total sound perception may be only slightly diminished. This distortion has been overlooked by many makers of hearing aids. As a result, they have had the opinion that the amplification should be arranged parallel with the patient's curve of threshold value rather than selectively. This opinion might be due to the lack of consideration of the recruitment phenomenon and the need of successive adaptation to the correct degree of selective amplification.

Holmgren describes in detail a special audiometer which he has built to overcome the imperfections of the audiometers on the market today. He has made valuable additions in order to take up physiologically correct curves for the threshold and to aid in trying out hearing apparatus. He utilizes a new technic of measurement, which he calls the "sliding tone," which implies that various points on the curve of the threshold are measured by maintaining a constant intensity and continuously varying the frequency, while with all other described methods, including those using the tuning fork and the audiometer, constant frequency must be kept up and the intensity varied. This continuous variation of frequency with simultaneous readable exact intensity of tone as constructed in his audiometer has definite advantages. Physiologically one utilizes a more nearly correct testing of the function of the auditory organ; from the otologic standpoint, the hearing tests are superior, partly in the presence of noise and partly in the prevention of the use of stationary waves, and from a technical standpoint the method is the only serviceable one for measuring the various effects of improvement in hearing within the different frequencies from which the amplification for speech can be calculated. A complete description of this audiometer is given in the monograph.

Any one interested in hearing and hearing aids should read this complete résumé with important conclusions, criticisms and suggestions made by Holmgren. A complete bibliography, in which American otologists are well represented, accompanies it.

Hill<sup>2</sup> brings out the advantages and value of the monochord for testing the upper limit of hearing for both bone and air conduction. He confirms Bunch's contention that it is the best device available for testing the upper limits. The chief handicap is its construction and the impossibility of measuring the intensity of its tones. The monochord has practically the same amplitude for both air and bone conduction. Normally the monochord is heard from 1000 to 2000 double vibrations higher by bone conduction than by air, which suggests that hearing by bone conduction is actually better than by air conduction. Tests with the monochord show that lesions in the middle ear definitely produce certain degenerative processes in the internal ear. According to Dean and Bunch, lowering of the upper limit of perception by bone conduction is more indicative of a lesion of the nerve or end organ than lowering of that by air conduction. Occasionally, the use of the monochord may materially change the audiometric picture and give a different conception of the condition. The audiogram may show a loss of hearing by bone conduction at frequencies of 1024 and above and yet the monochord may be heard up to 15000 double vibrations by bone conduction. In another case the same loss may be observed with the monochord also. The interpretation of the two conditions is different as regards the status of the internal ear. One is justified in assuming more severe involvement of the nerve in the second case than in the first. Patients showing a lowering of the upper limit of perception by air conduction may have normal upper limits for bone conduction, disclosing little destruction of the nerve mechanism for the high tones. However, if the upper limit for bone conduction is greatly lowered as shown by the audiometer and the monochord, one may assume the presence of severe perceptive deafness. The monochord is a valuable instrument and can be used routinely to advantage with the tuning forks and the audiometer in the functional tests of hearing.

Aschoff and Bayer<sup>3</sup> bring out the fact that otologists in the last decade have concentrated on several basic points concerning hearing tests. These are continuous production and unvarying energy of the test tones, testing of each ear independently of the other and testing of intensity of tone in relation to intensity of speech. Their studies of tuning forks, the monochord and the Bárány noise apparatus disclosed limitations in the use of these instruments. They found overtones present when testing perception of the lower tones with the tuning forks. These were eliminated by the application of weights or by using

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2. Hill, F. T.: The Use of the Monochord in Routine Tests of Hearing, *Laryngoscope* **49**:666 (Aug.) 1939.

3. Aschoff and Bayer: Contribution on the Question of the Physical Bases for the Use of Weighted Tuning Forks, Monochords, and Bárány Noise Apparatus in Hearing Tests, *Ztschr. f. Hals-, Nasen- u. Ohrenh.* **45**:77, 1939.

Bezold-Edelmann forks, which are overtone free. Quantitative and qualitative measurements of the upper and lower limits of audition are difficult to obtain with the monochord and tuning forks because of the fluctuation and the temporary lapse in the intensity of the sound waves produced. The results obtained with the Bárány noise apparatus did not follow any well defined course and were subject to great variation. The writers point out that nonelectrical instruments should not be underrated and that they will always play an important part in diagnostic studies. However, tuning forks and monochords do not come up to present day standards which the audiometers set by pure tone and volume control and the device by which the sound can be instantly produced or cut off.

Greenbaum, Kerridge and Ross<sup>4</sup> undertook an investigation to ascertain the normal range of hearing by bone conduction by testing a large number of young, healthy adults in a silent room, with an audiometer. Seventy-four men and 26 women were chosen, whose ages ranged from 18 to 25 and who had never had any aural disease.

The test tones were of frequencies of 64 to 8192 cycles in octave steps. The point of application on the mastoid of the receiver for testing hearing by bone conduction varied with each subject according to the optimum position for hearing as determined by changing the position of the receiver.

The average curve plotted from the results closely resembles that given in the instruction bulletin of the Western Electric audiometers, gradually increasing from 25 decibels at 64 cycles per second to 55 decibels at 512 cycles and then gradually decreasing to 25 decibels at 8192 cycles. However, the individual results showed somewhat wide variation. This emphasizes the fallacy of labeling bone conduction abnormal when a determination on a patient is compared with a measurement on a single so-called normal person.

Watkyn-Thomas<sup>5</sup> presents the etiologic factors of internal ear deafness, dividing them into two main groups, lesions of the nerve trunk and its central connections, and lesions of the middle ear. He does not believe there are any means available for distinguishing between a lesion sharply limited to the nerve trunk and a lesion of the cochlea. A diagnosis of internal ear deafness must never be made until one is sure by actual proof that the eustachian tube is patent and the drum membrane mobile. He has found a disparity often in the limit of perception for high tones as disclosed by the monochord and by the audiometer, the latter usually showing a greater loss. An attempt to estimate the intensity

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4. Greenbaum, A.; Kerridge, P., and Ross, E. J.: Normal Hearing by Bone Conduction, *J. Laryng. & Otol.* **54**:88 (Feb.) 1939.

5. Watkyn-Thomas, F. W.: Internal Ear Deafness, *Proc. Roy. Soc. Med.* **32**:487 (March) 1939; *J. Laryng. & Otol.* **54**:273 (May) 1939.

of the sound produced by the monochord might help to clear up this point. An important point in differentiating primary internal ear deafness and secondary nerve deafness due to otosclerosis is the patient's reaction to noise. The otosclerotic patient is either helped by noise or indifferent to it.

Watkyn-Thomas discusses a group of cases in which deafness occurs in the early forties with no definite etiologic factor. The audiograms are characterized by a sharp fall in the perception for high tones. He believes that the condition is due to toxic influences either blood borne or received via the middle ear. The most important, he feels, are the endogenous toxins produced by focal lesions. Bilateral deafness due to syphilis is a diminishing problem. Noise also is a factor to be considered. It is important to remember that in every case of internal ear deafness the most trivial and transitory additional middle ear deafness adds disproportionately to the patient's discomfort.

Perlman<sup>6</sup> reports a case of hyperacusis due to paralysis of the stapedius muscle in which hearing for sounds at and above the threshold, auditory fatigue and adaptation were carefully investigated. His findings corroborate those previously recorded on the action of the stapedius muscle and the part it plays in the function of hearing. Perlman, with Lindsay and Kobrak, in 1936 found that the threshold of the muscular contraction is about 65 decibels above the threshold of hearing, that the muscle does not enter into the mechanism of hearing for sounds under 65 decibels and that its function is probably to protect the cochlea when sounds of sufficient intensity and of sudden onset reach the ear. He suggests that two types of hyperacusis be differentiated: first, definite lowering of the threshold of hearing, or increased acuity, which may be termed "oxyecoia;" second, an abnormal discomfort caused by sounds above a certain intensity, which may be termed "hyperaesthesia dolorosa." The second type is considered due to paralysis of the stapedius muscle and has been known to accompany paralysis of the facial nerve. In the case reported the condition was of the second group, and the discomfort experienced by the patient was from sounds of intensities sufficient to produce contractions of the stapedius muscle. Fatigue of the auditory mechanism was more marked in the affected ear and required a longer period of recovery. The study of this case corroborates the findings previously recorded on the action of the stapedius muscle and the part it plays in the function of hearing.

Kelley<sup>7</sup> made a study of 88 persons over 50 years of age to determine the auditory loss with increasing age and its effect on the perception of

6. Perlman, H. P.: Hyperacusis, *Ann. Otol., Rhin. & Laryng.* **47**:947 (Dec.) 1938.

7. Kelley, N. H.: A Study in Presbycusis: Auditory Loss with Increasing Age and Its Effect on the Perception of Music and Speech, *Arch. Otolaryng.* **29**:506 (March) 1939.



music and speech. He found the hearing for 1024 cycles practically normal up to 70 years of age. Between 70 and 80 there was a loss of 14 decibels. At 50 presbycusis is apparent for frequencies of 2048 and above, the loss increasing as the frequency becomes higher. Presbycusis increases for the high frequencies with advancing age. His study reveals that a person with decreasing sensitivity for the higher frequencies does not experience the same quality in a musical tone as one with normal hearing. An orchestral selection heard by a person with presbycusis does not contain the same richness it did when his hearing was normal for the high frequencies. The complex tones lack brilliance, and qualitative differences are not detected. A person over 60 has no difficulty in recognizing vowels except at a low intensity, such as 10 decibels above the threshold. However, his recognition of consonants is inferior at all intensities when compared with that of a person with normal hearing. At the preferred intensity for ordinary conversation for persons with normal hearing, 38 decibels, the presbycusic person recognizes 75 per cent of the consonants.

Ansberry<sup>8</sup> tested two groups of persons, a normal one and one having impaired hearing, to determine the amplification above the threshold of hearing which is necessary before the sound becomes unpleasantly loud. The threshold of unpleasantness was taken where the tone was tolerable but not pleasant and not at the point where it produced pain. For every frequency from 64 to 8192 cycles the difference between the threshold of acuity and that of unpleasantness was at least twice as much for the normal person as for the one with impaired hearing, with an average difference of 24.9 decibels for the normal group and 10.887 decibels for the group with impaired hearing. The range, therefore, of usable, enjoyable sounds for the person with subnormal hearing is greatly reduced. This is an important difficulty to be considered in the fitting of hearing aids. An amplifier which responds more rapidly at one frequency than at another may break through this narrow band of pleasant sounds at that point. If the user then decreases the over-all volume it may cause the entire loss of the weaker sounds of speech, since they may lie in bands to which he is less responsive.

Jones<sup>9</sup> points out the importance of the use of tests which measure the perception above the minimal threshold. Some patients actually hear better than their minimal threshold indicates. In 1922 Jones tested patients with a simple vacuum tube amplifier and found that those with conduction defects heard well but that those with marked perceptive

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8. Ansberry, M.: Auditory Threshold of Unpleasantness in Normal and in Hard of Hearing Subjects, *Arch. Otolaryng.* 28:954 (Dec.) 1938.

9. Jones, I. H.: The Attempt at Precision Measurements of the Ear, *Laryngoscope* 44:505 (July) 1939.

impairments heard much better without amplification. This test can be applied today, a vacuum tube hearing aid being used as a diagnostic instrument. If the patient hears well with it, one knows that he has a conductive defect. This test is helpful in conjunction with the usual audiogram of the minimal threshold of hearing. It can be made under usual noisy conditions, and any vacuum tube amplifier can be used, but one that furnishes high quality amplification is preferable.

A sound-proof booth is necessary to detect beginning defects in hearing. The ideal opportunity for preventing deafness lies in the testing of school children. Nothing can compare with the systematic examination of all school children. If one uses the available tests for hearing, done properly in a sound-proof booth, even with their limitations, one will approach precision.

Bunch<sup>10</sup> reports a case of traumatic deafness following the explosion of a firecracker as further evidence of the relation between deafness and excessive stimulation by loud sounds. The reaction to the Rinne test was positive; hearing by bone conduction was somewhat decreased; perception in the Weber test was referred to the unaffected ear, and the loss of hearing for high tones was much greater than for low, the patient presenting a classic picture of primary perception or nerve deafness. Recovery took place in three days and was almost complete except for a marked dip at 4096 double vibrations, to approximately 45 decibels. Gaps of this nature, as pointed out before by Bunch, may result from excessive stimulation by industrial noises. They normally appear near 4096 double vibrations and are commonly found in the hearing records of hunters and sportsmen, who may be unaware of the condition and often have no loss in acuity of hearing for the spoken voice.

Selfridge<sup>11</sup> reports several cases in which deficiency of a vitamin was found associated with deafness for high tones. The patients showed variable improvements in hearing under vitamin therapy. He presents the problem to bring out the possibility of this factor being an additional cause for degeneration of the auditory apparatus.

Unger<sup>12</sup> utilizes the audiopupillary reflex in an objective test for hearing. This phenomenon was previously described by Cemach, Schurggin and others. This reflex is a quick consensual dilatation of the pupil followed by an equally quick contraction, which occurs when the ear perceives a loud noise. The contraction persists during the con-

10. Bunch, C. C.: Traumatic Deafness from the Explosion of a Fire Cracker, *Ann. Otol., Rhin. & Laryng.* **47**:1092 (Dec.) 1928.

11. Selfridge, G.: Eighth Nerve High Tone Deafness from a Nutritional Standpoint, *Ann. Otol., Rhin. & Laryng.* **48**:596 (Sept.) 1939.

12. Unger, M.: Objective Measurement of Hearing, *Arch. Otolaryng.* **29**:621 (April) 1939.

tinuance of the sound. Unger uses an audio beat frequency oscillator for his sound. Two ear phones are used, one for the patient and one for the physician. The dial is set for the frequency desired with the power off. The power is turned on slowly and the pupils watched carefully. When a quick dilatation is noted, the number of decibels is recorded. The test should be repeated several times to rule out accommodation.

To eliminate the possible confusion caused by the contraction of the pupil in accommodation, the patient wears a strong convex lens, of 40 diopters, which overcomes the ability to accommodate and also greatly enlarges the pupil. The examination may be tiring for both patient and examiner and may require two or more sessions. An accompanying graph shows the marked similarity of the two curves, that for subjective hearing and the other, in which the examiner noted the reflex. Unger feels that under proper conditions this test is remarkably accurate and that it is definitely useful in the detection of malingering. It should have a definite place in the examination of candidates for military service or victims of accidents when the question of impairment of hearing has to be considered. This appears to be a practical method for observing the pupillary reflex to sound.

The usual methods of testing the hearing consist of measurements of the threshold for various frequencies perceived by bone and by air conduction. The Weber test is mentioned as an exception; the Stenger test is not mentioned at all. De Maré<sup>13</sup> undertakes a series of carefully conducted experiments on the reaction of both normal and poor-hearing ears to tones of greater intensity than threshold under conditions of artificially induced fatigue, with masking and with the subjective sense of loudness. He starts by accepting as the most satisfactory theory of hearing the one which states that perception of sound is brought about by stimulation of the basilar membrane, different frequencies affecting different areas or bands of the membrane, intensity of perception depending on the number of neural elements involved. Patients with different types of deafness react differently under the handicaps mentioned. As a well known example he mentions paracusis Willisii; persons with obstructive deafness believe they hear better in a noise. Those with nerve deafness find that they hear much worse in noisy places. He believes that these tests may find valuable clinical diagnostic application and mentions E. P. Fowler's<sup>14</sup> recruitment of loudness test.

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13. de Maré, G.: *Audiometric Investigations of the Reaction of the Normal and Abnormal Ear Under Functional Handicap, Together with Observations on the Theories of Hearing*, *Acta oto-laryng.*, 1939, supp. 31, p. 1.

14. Fowler, E. P.: *The Use of Threshold and Louder Sounds in Clinical Diagnosis and the Prescribing of Hearing Aids*, *Tr. Am. Otol. Soc.* **28**:154, 1938.

With nerve deafness, with the threshold for a certain frequency higher in one ear than the other, when the intensity is increased sufficiently, it appears equally loud in both ears. He accepts this feature as characteristic of nerve deafness.

The author employed two audiometers and a rotary switch which automatically interrupted the tones. For the masking test, he used the interrupted tone of four-tenths second's duration at intervals of three and five-tenths seconds, masked by a continuous tone; for the fatigue, or adaptation, test, after exposure to a certain frequency he remeasured the threshold for that frequency. He also switched in a "fatiguing" tone in the intervals of the interrupted tone and measured in decibels the amount necessary to blot out the interrupted tone. The results are statistically presented. The fatigue appears not to depend either on psychic influences or on the musculature but rather corresponds to the process of adaptation of the hearing receptors. The pathologic material was taken from cases of pure conduction deafness, of pure nerve deafness and of mixed types. In patients with conduction deafness the effect of fatigue was less marked than in normal persons and was approximately in proportion to the degree of deafness. In patients with nerve deafness it was equal to or more marked than that in normal persons; i. e., the former were more easily fatigued. The author suggests the possibility of this test serving to diagnose even different types of damage to the perceptive apparatus. The masking effect is less in patients with all types of deafness than in normal persons. It leaves unexplained why patients with nerve deafness hear less in a noise than those with conduction deafness. Perhaps this is due to a different irritation curve in the basilar membrane in the two conditions.

There is a complete review of the literature citing a number of American references unusual on the part of a European investigator. The monograph represents a painstaking investigation in a relatively new field of functional testing.

Crowe<sup>15</sup> states that the only way to make a satisfactory differential diagnosis of deafness is to take a detailed history, to examine the upper air passages, the tympanic membranes and the eustachian tubes and to use masking when making the hearing tests. The audiometer test must always be supplemented with fork tests. It is essential when one is interpreting an audiometer chart to know that the hearing for the high frequencies becomes more and more impaired with each decade. The three conditions in the middle ear which impair hearing are partial or total obstruction of the eustachian tube, any lesion that interferes

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15. Crowe, S. J.: *Diagnosis and Differential Diagnosis of Deafness*, Arch. Otolaryng. 28:663 (Nov.) 1938.

with the movement of the ossicles and fixation of the footplate of the stapes due to otosclerosis. It is important to know that during the early stages of obstruction of the eustachian tube in children the hearing is more impaired for high than for low tones. If this condition is not recognized and properly treated in its incipency, the impairment of hearing progresses from one octave to another toward the low end of the scale. When the hearing for tones between 2000 and 4000 double vibrations becomes involved, the patient begins to be noticeably deaf. This may take ten years or more, and when it does occur the damage to the middle ear is often permanent. To diagnose overgrowth of lymphoid tissue around the orifice of the eustachian tube, examination with the nasopharyngoscope with some form of anesthesia is essential. Correlation of the results of functional tests with those of histologic studies shows that any lesion interfering with the movement of the ossicles causes marked loss of hearing. When the movement of the malleus and the incus is impaired, the loss of hearing usually begins with the higher frequencies, whereas with involvement of the stapes alone perception of the low as well as of the high tones is impaired.

Crowe gives several illustrations of conditions in which early stages of involvement of the inner ear or of the cochlear nerve may cause selective loss of hearing for high tones. A study made several years ago brought out two points of practical importance. When the middle ear and the eustachian tube are normal and the impairment of hearing begins at 256 or 512 double vibrations and increases gradually with each octave toward the high end of the scale, the lesion is atrophy of the cochlear nerve supplying the basal turn of the cochlea. The organ of Corti is not affected. When under the same conditions the audiogram shows abrupt or sharply localized impairment of hearing for the high tones, both the nerve and the organ of Corti are atrophic.

Crowe and Baylor<sup>16</sup> present some of the preliminary conclusions from their studies of over 15,000 records of hearing tests covering fourteen years. The study was to correlate impaired function as determined by clinical tests with the location and nature of the causal lesion. They found that long-continued partial obstruction of the eustachian tubes in children causes retraction of the tympanic membranes, impaired hearing for high tones with relatively good hearing for the low tones and sometimes total loss of hearing by bone conduction. This revolutionary statement is based on a study of 60 children over ten years. In all the cases the pharyngeal orifices of the eustachian tubes were partially occluded with nodules of lymphoid tissue. The

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16. Crowe, S. J., and Baylor, J. W.: *The Prevention of Deafness*, J. A. M. A. **112**:585 (Feb. 18) 1939.

earliest symptom of such partial obstruction is impaired hearing for tones between 10,000 and 16,000 double vibrations. If untreated, the deafness progresses, involving one octave after another toward the low end of the scale, and becomes evident when the speech range becomes affected. If the causal condition is properly treated before the age of 15, hearing usually returns to somewhere near the usual level. After this age, the results are far less satisfactory, and secondary changes in the middle ear may be so advanced that they can be repaired by no treatment whatever. The most satisfactory method of treatment is irradiation with radium or roentgen rays. This may not permanently remove hyperplastic lymphoid tissue, but relatively small doses keep it in abeyance during the age in which it grows most actively. They stress the importance of nasopharyngoscopic examination in such cases for both diagnosis and, if necessary, treatment, general anesthesia being used if required for the examination. They feel that if school children in the primary grades were examined with the nasopharyngoscope at least once a year and those with hyperplastic lymphoid tissue in and around the orifice of the eustachian tubes were treated with radiation as often as necessary to insure normal function of the tubes, the number of deaf adults in the next generation could be reduced by 50 per cent.

Crowe<sup>17</sup> presents his views on progressive deafness in another article also. He emphasizes the following points which must be accepted or proved before one can recognize and intelligently treat this type of deafness. Impaired hearing for the higher frequencies with good hearing for low tones does not always indicate an irreparable lesion of the inner ear or the nerve. A long-continued obstruction of the eustachian tubes may produce marked shortening or total loss of hearing by bone conduction for the 512 double vibration fork, and the hearing can often be restored to normal.

Retraction of Shrapnell's membrane in a child with an otherwise normal-appearing drum is a danger signal of impending loss of hearing and warrants a search for the cause, which may be partial closure of the eustachian tube. All lymphoid tissue is not necessarily removed when the tonsils and adenoids are removed. Nodules of lymphoid tissue may appear in the pharynx after operation. This condition may not be recognized when it occurs around the orifices of the eustachian tubes unless a nasopharyngoscope is used for examination. In order to safeguard the hearing, it is advisable to make such an examination once or twice a year until puberty.

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17. Crowe, S. J.: The Prevention of Deafness in Children, *Laryngoscope* 49:591 (July) 1939.

Pohlman<sup>18</sup> brings out the point that it was unfortunate that Crowe and his workers reported only on the sensitivity by bone conduction to a 512 double vibration tuning fork. The writer presents 2 cases of adults showing a similar curious limitation in the conduction of sounds of high frequency, with a negative reaction to the Rinne test for these sounds, in whom the eustachian tubes were patent. In 1 the condition was quite definitely due to changes at the footplate of the stapes. Study of these cases indicates that the peculiar findings may result from conditions other than blocking of the eustachian tube. It also emphasizes the importance of an audiometric examination throughout the frequency range for both air and bone conduction before a definite diagnosis of a mixed deafness may be made.

Bunch<sup>19</sup> attempts to answer some of the questions pertaining to the progress of deafness in otosclerosis. A series of patients was tested and observed over six years. Although this period covers only a small part of a lifetime, it is significant that the evidence obtained does not reveal an average measurable increase in the loss of hearing during this time. When the deafness had increased an obvious factor was not found to account for it. Changes, either improvements or regressions, were often unilateral and varied in different frequencies. Time alone is not the factor determining the progress of the deafness. Bunch noted that when the patients were fatigued they exerted additional physical and nervous energy to understand conversation. As a result they eventually ceased to listen and gave the impression of a greater loss of hearing than actually existed. Six women were observed who had borne children during the period. Tests were made before and after childbirth and also at a later date. None of the subjects showed any definite increase in deafness associated with childbearing.

Lüscher<sup>20</sup> states that audiometric examinations have shown that the rule that interference with the conduction apparatus affects primarily or exclusively the hearing for low tones and that disturbance of the perception apparatus affects that for high tones no longer holds. As a matter of fact, he says, there is still lack of clarity in correlating the curves of audiograms to the location and type of aural involvement, and only rarely is it possible to draw unquestionable conclusions regarding the exact nature of the aural impairment. He quotes the work of Crowe

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18. Pohlman, A. G.: A Note on the Greater Disability for Hearing High Tones in Cases of Conduction Deafness, *Ann. Otol., Rhin. & Laryng.* **48**:596 (Sept.) 1939.

19. Bunch, C. C.: The Progress of Deafness in Clinical Otosclerosis, *Laryngoscope* **49**:793 (Sept.) 1939.

20. Lüscher, E.: Investigation of the Influence on Hearing Ability of Strain on the Ear Drum, *Acta oto-laryng.* **27**:250, 1939.

and Guild, who demonstrated marked loss of hearing for high tones in some cases of stenosis of the eustachian tube.

The determinations of the thresholds of hearing were made with the oto-audion designed by Kraft. Then Lüscher produced disturbance of the conduction apparatus by employing four methods of weighting the tympanic membrane:

1. "Point" loading of the umbo with increasing weights.
2. Loading of the pars tensa with drops of mercury of various weights.
3. Loading of the pars tensa with drops of water of varying weights.
4. Filling the external auditory canal with water.

The ear not under examination was plugged with "oropax" [composition not stated]. The tests were made with the patient lying down and with the tested ear about 20 cm. from the loud speaker. In each instance a careful audiometric examination was made before the various methods of loading were carried out. After this in most cases the ear was again checked unweighted. The preliminary and the final curves showed a maximum variation of only 2.5 degrees on the audiometer curve.

The conclusions are as follows: 1. "Point" loading of the umbo to the extent of 3.66 and 6.66 Gm. (by means of a rod with a small sphere on the lower end and a plate on the upper end on which weights were placed) produced strikingly small disturbances of hearing, with loss for the lower and middle ranges but preservation of the upper tone limits. 2. Loading of the pars tensa with drops of mercury to the extent of 0.5 to 2.0 Gm. gave light to marked impairment of hearing with lessening for all tones but most marked loss for the middle to the high range and lowering of the upper tone limit. 3. Loading with drops of water, 0.05 to 0.25 Gm., produced changes qualitatively similar to those produced with mercury but of less degree. 4. Filling the external auditory canal with water caused marked impairment of hearing similar to that produced by loading with mercury. 5. The classic dictum that loss of hearing for the lower range is most marked applies in only a portion of cases of involvement of the middle ear. Judging from the clinical audiograms, there are several types of disturbance of hearing in the middle ear, of which a portion show involvement mainly for the tones from the middle range to the upper limit.

Fifteen years ago Sonnenschein<sup>21</sup> reviewed the extensive article by Runge on the "water filling test." This splendid monograph dis-

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21. Sonnenschein, R.: The Functional Examination of Hearing: Annual Summary on the Problems of the Deaf, Papers Relating to Deaf-Mutism and Education of Deaf Children, Mechanical Devices for Hearing, Lip Reading, and So Forth, Arch. Otolaryng. 1:89 (Jan.) 1925.



cussed many phases of bone conduction. Runge found in a series of cases of otosclerosis no lengthening of perception by bone conduction when the water filling test was used, but when the otosclerosis was light and the hearing for the whispered voice still good slight prolongation was noted.

In cases of cochlear degeneration the bone conduction, which had been greatly reduced, was usually doubled in length by the water-filling tests. In the early and in the final stages of acute otitis media, the bone conduction is diminished with the test as compared with a normal ear; in well developed acute otitis the bone conduction is not increased by the water filling.

. . . [Runge] also believes that the increased bone conduction normally present when the ear is filled with water is due to two things, namely: (1) A better transmission of sound to the drum membrane by the fluid, (2) to a diminished "outflow" or escape of sound from the ear; it seems the former is the more important factor.

Macfarlan<sup>22</sup> traces the history and development of audiometry. He mentions the first devices capable of producing sounds of controlled intensity. The advent of simple electric circuits produced the buzzer type of audiometer. The noises were an unknown mixture of frequencies, testing with which gave no data on the hearing in various parts of the auditory range. In 1903 Dr. Sohler-Bryant presented a phonograph audiometer for testing speech, and several years later the "audiophone" was introduced, which was a phonograph with an electric pick-up with speech sent through a telephone receiver. In 1920 Carl Seashore introduced the use of special records to determine such factors as the appreciation of pitch, intensity, interval and consonance. The next development in phonographic audiometry was the 4-A audiometer of the Western Electric Company. Mechanical equipment is now becoming better and the methods of testing are constantly being improved with the more thorough scientific knowledge of speech and of the hearing of speech.

In 1921 Dr. John Guttman introduced and described an electric acoumeter which was the first instrument to use vacuum tubes for testing hearing. The first frequency run audiometer developed especially for testing hearing was the Bell Laboratories' eight octave audiometer known as 2-A. Harvey Fletcher introduced this in his article in 1925 and introduced also the new unit of intensity, the decibel. Macfarlan gives a list of the audiometers now actively on the market and also names the oscillators adaptable for use in testing hearing. Progress has been made also toward the standardization of these instruments. Macfarlan concludes his paper by listing the names of Americans and other otologists who have made contributions to the development of audiometry.

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22. Macfarlan, D.: History of Audiometry, Arch. Otolaryng. **29**:513 (March) 1939.

The Council on Physical Therapy of the American Medical Association<sup>23</sup> published the following requirements for acceptable audiometers: Audiometers shall be equipped for testing both bone and air conduction; they shall have fixed or continuous frequencies from 128 to 8192 cycles; the frequency of each tone shall remain within plus or minus 5 per cent of the designated value; calibration shall be in decibels, with 5 decibels per step or less; requirements for purity of tone shall be met; extraneous noises shall be at least 60 decibels below the level of the test tone for frequencies of 1024 cycles and higher and at least 40 decibels below the level of the test tone for frequencies below 1024 cycles; the bone conduction receiver shall not produce sound in the air so that it could influence the validity of the measurement of bone conduction, and the audiogram blank shall use the same base line for the results of both air conduction and bone conduction.

Newhart<sup>24</sup> reports on a new pure tone audiometer especially designed for individually testing the hearing of large groups, particularly school children. This is known as the Maico D-6 school audiometer. The special features of this instrument are its low cost, uniform zero reference lever and illuminated, easily read intensity and frequency dials.

Its operating range is from 128 to 8192 cycles at fixed intervals at one octave with intensities variable in steps of 5 decibels. Thirty to 50 persons per hour, or 150 to 250 per school day, can be tested. This instrument is not intended for diagnostic purposes, as it does not include means for bone conduction tests or masking.

In view of the researches being pursued at McGill University it was found necessary to improve the audiometric methods used at the Montreal General Hospital.<sup>25</sup> With precise measuring instruments, it was found, the recorded results could still be largely affected by the method of application of the stimulus, the reliability of the subject's response, the control by the technician and the recording of observations. To overcome the objections to the usual ear phone, the patient is placed in a thoroughly sound-proof room, in an open sound field produced at a convenient distance from a loud speaker. To obtain reliable responses from the subject, a technic is used involving successive trials by stimuli selected at random in the neighborhood of the threshold. A machine is used called the random stimulus selector, which selects at random one of six intensities chosen or the zero intensity and presents this to the patient, lighting a lamp to inform the patient that the test is proceeding. A switch

23. Minimum Requirements for Accepted Audiometers, report of the Council on Physical Therapy, J. A. M. A. **112**:732 (Feb. 25) 1939.

24. Newhart, H.: A New Pure Tone Audiometer for School Use, Arch. Otolaryng. **25**:777 (Nov.) 1938.

25. Barr, E. G., and Mortimer, H.: Improvements in Audiometry at the Montreal General Hospital, Canad. M. A. J. **40**:22 (Jan.) 1939.

provides the choice of either a 20 decibel or a 10 decibel range to be covered by the six intensities. It counts the number of trials of each intensity and locks each out of use when the stated number of trials of the intensity is completed. This can be adjusted at from one to ten trials, but five trials are generally used for each of the six intensities at each frequency. To control the recording of operations, electric solenoid operating mechanisms are provided for eight keys of a standard typewriter. When the patient presses a "no" button, a semicolon is typed, and when he presses a "yes" button an asterisk is typed if the zero stimulus is presented, or one of the letters "a," "s," "f," "g," "j," or "k" according to which of the six differing intensities was then presented to the patient. After the patient has pressed one or the other of the reply buttons, he is unable to alter the course of events, which is in the following sequence. The typing of the reply is immediately followed by deenergizing of the random stimulus selector. Everything is automatic except that the patient presses the button. The time of the test for five trials of each intensity varies with the quickness of the patient but generally is from four to five minutes. The range of indecision of new subjects is found to be as narrow as with skilled subjects. This type of installation is applicable also to other fields of investigation, such as comparison of the threshold with and without a hearing aid and comparisons of levels at which articulation is clear. Charts showing the recording of the tests and a complete description of the construction of the sound-proof room accompany the article.

In subjective tests it is doubtful whether the responses of a patient of questionable intelligence are as reliable as the observations of a trained investigator.

Newhart and Hartig<sup>26</sup> describe the construction of a practical, efficient, portable and inexpensive booth for testing hearing. It has a relatively high effectiveness in reducing noise and is most efficient in attenuating high-pitched sounds. The form of construction and the method of assembly are fully described and pictured.

Ciocco<sup>27</sup> presents the results of examinations of the hearing of 552 children who had been tested five years earlier. The results show particularly changes in acuity of perception by air conduction. The various degrees of impairment of hearing were defined as follows: Good hearing was present when the tones tested, namely, 64 to 8192 double vibrations, were heard at 20 decibels or less. Slight loss for tones of the speech range was present when one or more tones of the low or middle range, up to 1024 double vibrations, was heard only at 20 to 35

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26. Newhart, H., and Hartig, H. E.: An Efficient and Practical Booth for Testing Hearing, *Arch. Otolaryng.* **28:1000** (Dec.) 1938.

27. Ciocco, A.: Audiometric Studies on School Children, *Ann. Otol., Rhin. & Laryng.* **47:926** (Dec.) 1938.

decibels, and hearing for the upper range was within normal limits. Marked loss for tones of the speech range was present when the low range was heard only at 35 decibels or above while the higher tones were heard at any intensity. Slight loss for high tones was diagnosed when tones ranging from 2048 to 8192 double vibrations could be heard at 20 to 35 decibels, and the remaining tones at frequencies equal to or less than 20 decibels; marked loss for high tones was present when the upper tones were heard only at or above 35 decibels.

This investigation revealed that the frequency of loss for high tones had increased by about 300 per cent in the group, whereas impairment for tones in the speech range had increased only by about 20 to 30 per cent. About one fourth of those who previously had had slight impairment were worse but remained with the same type of impairment. When marked impairment had been found five years before, a similar condition still existed in the majority in this group. The development of impairment of perception for tones of the low and middle ranges does not seem to be related either to the sex of the child or to the age at the first examination. However, the number of children in whom slight loss of hearing for high tones developed increased concurrently with the age of the children at the first examination. The percentage of the children in whom loss of hearing for high tones developed increased with age up to 10 years and decreased thereafter. The percentage of boys who acquired marked loss of hearing for high tones during the interval was three times that of the girls. The other forms of auditory defects developed with equal frequency in the two sexes.

Hughson, Ciocco and Palmer<sup>28</sup> made careful audiometric studies of 460 profoundly deafened children of the Pennsylvania School for the Deaf, to provide data for future pedagogic and possible therapeutic effort. They found that the great majority of these children had a bilateral defect approximately the same in the two ears. Complete lack of response to auditory stimulation is rare. Ninety-five per cent of the group responded to at least one tonal frequency by air conduction in one ear and 85 per cent in both ears. The percentage of children who became deaf after birth was highest at 1 year of age and decreased rapidly at each successive year. Fifty-four per cent were born deaf. The acuity of hearing was essentially the same for both those born deaf and those who acquired the loss in early infancy and childhood. The important causative factors for the acquired deafness were meningitis, trauma to the head, measles, otitis media and scarlet fever. These comprised the cause in 50 per cent of the cases, of which meningitis alone produced the condition in 17 per cent. There is apparently no association between

28. Hughson, W.; Ciocco, A., and Palmer, C.: Studies of Pupils of the Pennsylvania School for the Deaf, *Arch. Otolaryng.* 29:403 (March) 1939.

auditory thresholds and the stated cause of deafness. A significant number of the children were found to have enough residual hearing by either air or bone conduction to warrant some rational effort toward therapeutic relief.

Fry and Kerridge<sup>29</sup> present the tests for hearing of speech by deaf people. These are used at the hearing aid clinic at the University College Hospital, London. Although they realize that speech tests are not accurate, nevertheless they feel that there are times when some sort of voice test with a detailed measurable result is helpful, as when deciding between possible settings of a tone control on a valve amplifier hearing aid. It has been found that the important requirements for a good test for deaf people is a simple short test which takes into consideration how frequently sounds occur, as well as their variety, and a speaker with a familiar voice. Two types of test are used: lists of monosyllabic nouns and short commonplace sentences. The former is used for people who understand isolated but common words; the latter, for those who require help from the context to comprehend the meaning. The nouns are grouped in five columns of twenty-five words and the sentences in five series of twenty-five each. One series is used on any one occasion of testing. The room is relatively quiet, with noise not more than 30 phons. The speaker should be some one with whose voice the deaf person is familiar, as a member of his family. The distance should be 4 to 16 feet (122 to 488 cm.), depending on the deafness of the patient. This distance is in accordance with private conversations or general conversations. The patient's eyes should be closed to avoid lip reading. Four marks are allotted to each word or sentence. In the sentence a wrong word constitutes one mistake. In the word test, one mistake consists of an error in initial, vowel or final sound, and one mark is deducted for every fault. Any person whose total score is less than 35 per cent on the word test should be retested with the sentences.

Harms and Malone<sup>30</sup> present data to show that stammering is rare in those with total loss of hearing. They show, however, that loss of acuity of hearing during the period of formation of speech may be a cause of stammering in persons who are unaware of any loss of hearing. All showed loss of hearing varying from 10 per cent to 22 per cent. This strongly suggests the relation between loss of hearing and the development of stammering. Hearing aids should be used in correction of speech which cannot be improved to a useful level by other therapy.

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29. Fry, D. B., and Kerridge, P. M. T.: Tests for the Hearing of Speech by Deaf People, *Lancet* 1:106 (Jan. 14) 1939.

30. Harms, M. A., and Malone, J. Y.: Hearing Acuity and Stammering, *Ann. Otol., Rhin. & Laryng.* 48:596 (Sept.) 1939.

Goldstein<sup>31</sup> stresses the importance of residual hearing in the education of the hard of hearing child. He states that about 30 per cent of all congenitally deaf children have some residual hearing. In considering congenital deafness, Goldstein mentions several types of deafness and aphasia which have to be considered in making a diagnosis. The so-called "word deafness" is a condition in which the child may hear what is being said but is unable to analyze and interpret the sounds heard. Such children when properly trained frequently make such progress as to be able to carry on later in the normal classroom. Another condition to be considered is "congenital aphasia" or the mechanical inability to produce speech. Children with this condition may have normal hearing and may be incorrectly classified as congenitally deaf. Congenital "word deafness" (inability to understand and to use the spoken voice) may be present with normal hearing. Differentiation between a child having an involvement of the cortical speech areas and a congenitally deaf child may be difficult.

Various tests are employed in the diagnosis of congenital deafness. There are but few tests that can be accurately applied to a child under 2 or 3 years of age. The voice test for children of this age should be ruled out, as they have not acquired sufficient knowledge of speech to insure correct response to questions. In a normal child some change in the position of the head, usually toward the source of the sound, is usually elicited when some familiar sound is made close to the ear. Such sounds as stamping of the feet, shrill whistles and claps of thunder are not regarded as providing an adequate test by the writer. High-pitched forks or Galton whistles are of no avail when nerve deafness is present, and low-pitched forks may elicit a tactile response rather than that of hearing. The palpebral reflex test is of questionable reliability.

Important information can be obtained from the labyrinthine tests.

Whenever a young child (aged one to four years), profoundly deaf, is found to have a normal nystagmus reaction or even nystagmus of reduced duration, the assumption is justified that the acoustic labyrinth is not entirely without function. . . . This type of patient, then, whether deafness is congenital or acquired in etiology, must be assigned to special training in speech and lip-reading.

The audiometer offers an additional means of determining residual hearing. When a congenitally deaf child does not respond to tones within the range of 300 to 3000 double vibrations when tested with a high-powered audiometer intensified to over 100 decibels, he must be considered profoundly deaf, with scant hope of reeducation or restimulation.

The presence of residual hearing can be determined also with the voice at close range. When residual hearing is found, training should

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31. Goldstein, M. A.: *The Education of the Deaf and Hard of Hearing Child*, *Am. J. Surg.* 42:151 (Oct.) 1938.

be employed by what is generally termed the acoustic method. This method is defined by Goldstein as "stimulation or education of the hearing mechanism and its associated sense organs by sound vibration as applied either by voice or any sonorous instrument."

There are two types of acquired deafness: one which occurs before speech has been acquired and a second which occurs after fluency of speech has been established. A patient with the first type requires the same pedagogic training as the congenitally deaf child. In the second type lip reading and the preservation of speech are essential parts of the education. The question of the rehabilitation of the hard of hearing child is so important that some means must be found to supply adequate training for those with this type of physical handicap.

Keen<sup>32</sup> presents his observations on the relation between tests by the voice, the gramophone audiometer and the pure tone audiometer. Twenty-two audiograms were available from pupils of a special school for the deaf. Keen cautions one to be sure to check the output of the gramophone audiometer and determine whether it actually is the same as the decibel readings given on the machine. He also stresses the point that the two zero conceptions, of the gramophone audiometer and of the pure tone audiometer, do not correspond. One test involves the understanding and writing down of numerals, while the other is simply the hearing of a pure musical note, a process of perception which is comparatively easy for the ear and brain centers. As a whole, he finds that the correlation between the results is clear and appears rather accurate when one takes into consideration the widely different nature of the three methods of testing the hearing. Several factors may help to explain discrepancies between the different tests. A period of several months elapsed between the application of the three methods, and differences in the physical state of the child, as well as in the ears, may account for some of the discrepancies.

The results of the gramophone audiometer test were considerably higher than those of the voice tests. This may be due to a miscalculation in determining the comparative levels of loudness on the scale of the gramophone. More likely it is due to a mechanically reproduced voice of particular clarity remaining close to the ear being perceived more easily than the voice of a person gradually moving away from the ear. In addition, the repetition of the numbers given on the gramophone may aid in their reaching the brain centers after a while, for, on the whole, the gramophone audiometer test requires a smaller effort of concentration than the voice test.

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32. Keen, J. A.: Some Observations on the Relation Between Tests by the Voice, Gramophone Audiometer and Pure Tone Audiometer, *J. Laryng. & Otol.* 53:581 (Sept.) 1938.

Newhart and Hartig<sup>33</sup> in discussing hearing aids bring out the necessity for otologists to have an elementary knowledge of the construction, performance and limitations of these instruments in order to render the best service to their patients. Three indispensable elements in the normal process of communicating ideas by speech have to be considered. These are the speaker, the listener and the path of sound transmission. Each element must function properly for a high degree of understandability. Enunciation must be clear and loud, the listener's hearing must be normal and the path of sound transmission must be free from echoes, reverberation, interfering noises or distortion. To offset the insufficient intensity of sound, amplification must be resorted to. External distortion of speech must be taken into consideration, namely, that kind which has the property of subtracting from the normal speech sounds, such as impairment of hearing, and that which adds noise components, such as is introduced by electrical hearing aids of the carbon microphone type.

Invaluable information is obtained from an audiogram for both air and bone conduction. Similar information may be obtained with the tuning forks, but less accurately. The audiogram indicates whether an air or bone conduction receiver should be used, the degree of amplification required at the different frequencies and whether the deficiency is such as will enable the person to wear either a carbon aid or a vacuum tube amplifier. Persons whose loss of hearing is moderate and fairly uniform through the speech range can be easily fitted with a carbon microphone aid, whereas those with a severe loss, especially for the higher frequencies, present a more difficult problem. Improvements in the range and the quality of the performance of hearing aids, the development of selective amplification and the perfection of wearable vacuum tube instruments have greatly increased the field of application of electric hearing devices. The otologist should be well equipped with an instrumentarium and with technical knowledge in order to show the patient that he is better prepared to serve him than is the high pressure salesman. He should protect his patient by giving him the benefit of aid in choosing a hearing device from the accepted models and should help him in deciding which is most suitable for him. Otologists should also encourage the makers of high grade hearing aids to submit their products to the Council on Physical Therapy of the American Medical Association for acceptance.

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33. Newhart, H., and Hartig, H. E.: Hearing Aids, *Arch. Otolaryng.* **29**:614 (April) 1939.

34. Aubry, M., and Giraud, J. C.: Study of Bone Conduction for Diagnosis and Prognosis, *Presse méd.* **47**:653 (April 29) 1939.



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quencies up to 1024. Above that frequency the vibrations go directly through the bone to the cochlea, and perception of them is affected only by blocking of the round window.

Reboul<sup>35</sup> states that at frequencies under 700 double vibrations the basilar membrane swings as a whole; therefore, for those frequencies it cannot act as a resonator, and they must be centrally differentiated. Above that pitch some bands of frequencies permit peripheral analysis. The differential between the perilymph and endolymph, influenced by vibrations, may explain the Wever-Bray phenomenon.

Arapova and Gersuni<sup>36</sup> state that the alternating current causes a sensation of sound in the normal ear. With inner ear deafness this is diminished; with conduction deafness it remains unaltered.

Nussdorfer<sup>37</sup> asserts that loss of hearing for tones from 4096 cycles upward begins even in the second and third decade, both by bone and by air conduction. There is some loss by both bone and air conduction throughout the entire range. A relatively small loss is present at the lower frequencies. There is abnormal fatigability.

Using high and low tones to test fatigability, Navyazhskiy<sup>38</sup> found that high tones induce greater fatigue. He believes it is a central effect. When both high and low tones are used there is less fatigue. The author believes the low tone masks the high one and so prevents central fatigue.

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35. Reboul, J. A.: Remarks on the Theory of Hearing, *Rev. de laryng.* **60**:144 (Feb.) 1939.

36. Arapova, A., and Gersuni: Electric Reaction of the Hearing Organ in Various Conditions, *Fiziol. zhur.* **25**:430, 1938.

37. Nussdorfer, R.: Audiogram of Senile Deafness, *Atti clin. otol. Torino*, 1938, p. 43.

38. Navyazhskiy, G. L.: Fatigue of the Ear and Masking, *Fiziol. zhur.* **25**: 353, 1938.

# Abstracts from Current Literature

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## Ear

WHAT IS PERCEPTION DEAFNESS FROM A PHYSIOLOGICAL AND HISTOLOGICAL BASIS? M. H. LURIE, *Ann. Otol., Rhin. & Otol.* **48:3** (March) 1939.

The author points out that hearing is a process which concerns more than the ear alone; it is the interpretation by the brain of the various impulses sent to it by the organ of Corti. Perception of sound is the same in all mammals, but interpretation depends on mental capacity. Deafness may be divided into (1) the inability of sound to reach the end organ (conduction deafness) and (2) the inability of the end organ or brain to receive or interpret the sound waves (perception deafness). The first is mechanical rather than true deafness.

In discussing the function of Corti's organ, the author states that the tectorial membrane should be regarded as a modified otolithic structure, its function being similar to that of the otolithic membrane of the vestibular apparatus, aiding in the movement of the hairs of the external and internal hair cells. He does not agree with Wittmaack's claim that these hair are artefacts. The tectorial membrane is in intimate contact with the organ of Corti.

The stria vascularis is similar to the choroid plexus of the brain, and the endolymph is secreted by it. The author questions whether changes in the stria will cause deafness, as many animals with normal hearing showed changes in this structure.

It has been maintained that vibration of the basilar membrane on which Corti's organ rests is not necessary for hearing. Lurie cites his experiments showing that the basilar membrane can be made to vibrate sufficiently to throw off the organ of Corti with a resulting loss of response from that region. The organ of Corti rests only partially on this membrane, the external hair cells and external pillar cells resting on it while the internal hair and pillar cells rest on bone, thus allowing greater movement of the external than of the internal cells. The internal pillar cell has a sort of hinge socket for the head of the external cell. Because of this arrangement of the internal and external hair cells it appears likely that the external cells are affected before the internal. The author cites experiments on guinea pigs in which they were exposed to an interrupted tone of 2,500 cycles at high intensity for a long time and showed a loss of 10 to 40 decibels according to the number of external hair cells destroyed, a loss of hearing similar to boiler-makers' deafness. The animals were not totally deaf but lost only part of the hearing, the internal hair cells responding to sounds, but at higher intensities. These experiments indicate a difference in function between the internal and the external cells, the external cells responding to weaker and the internal to more intense stimuli. Animals made deaf by quinine showed similar degeneration of the external hair cells, indicating that these cells are not only more sensitive but also more liable to degeneration from trauma or toxins than the internal.

Perception deafness can be considered a degeneration of the external hair cells of the organ of Corti. Lurie points out that a single nerve fiber supplies a large number of external hair cells, while only one or two of the internal cells are supplied by a single fiber. The external cells pick up sounds of small intensity, as with a multiple nerve supply they detect slight changes more easily; also there is no fine discrimination of pitch in the external cells. The single nerve supply

of the inner hair cells points to a more accurate determination of pitch, since a difference could be picked up two hair cells apart. With the external cells this difference would be many cells apart.

The organ of Corti can remain functioning for a long time after section of the nerve to the cochlea, and this may explain the recovery of hearing in cases in which there has been complete deafness during the course of a disease. When the neuritis disappears or the nerve regenerates, normal connections between the brain and the end organ are again established. M. V. MILLER, Philadelphia.

AN OPERATION FOR POSSIBLE ALLEVIATION OF CERTAIN CASES OF CONGENITAL DEAFNESS AND CERTAIN TYPES OF ACQUIRED CHRONIC DEAFNESS. EARL C. PADGETT, *Ann. Otol., Rhin. & Laryng.* 48:113 (March) 1939.

The author points out that in spite of anomalies of the external ear, even in cases of congenital atresia of the external canal, there may be at least some partially functioning middle ear. One should be as sure as he can that there is a functioning auditory apparatus before operation is advised for building an external auditory canal. If there is a deformity of the auricle, especially with meatal atresia, the motion of the soft palate should be tested. When the deformity is unilateral and both palate arches move symmetrically, it shows a possibility of both eustachian tubes and middle ears being in fairly normal condition. If faulty motion is noted on the involved side there is probable impairment of the tube and tympanum on that side. Malformation of the middle ear is often associated with poor development of the muscles of the palate and eustachian tube. Needle puncture of the closed canal will show whether atresia is due to a fibrous, membranous or bony tissue. Stereoptic roentgenograms may help. The Weber test is helpful for intelligent patients.

The unsatisfactory results of intrameatal operations were pointed out and also the dangers of attempting to enlarge the bony canal, largely because with congenital malformations the facial nerve may be in an unusual position and may be injured. Padgett advocates a two stage operation to develop a new external canal posterior to the normal position, running through the mastoid process. A flap of skin is elevated from the mastoid, and the skin for the new canal is made from this after the canal is made through the bone. This may be allowed to open behind the ear or may be implanted into the cavum conchae, the latter at the second operation. He reports that Dr. O. Jason Dixon has done the operation in 15 cases.

M. V. MILLER, Philadelphia.

LATE EAR HEMORRHAGE FOLLOWING SKULL FRACTURES. W. E. GROVE, *Ann. Otol., Rhin. & Laryng.* 48:120 (March) 1939.

Bleeding from the ear after injuries to the head is almost pathognomonic of fracture of the temporal bone, usually longitudinally through the petrosa. Most authors agree with this and also that the drum is torn only when the fracture reaches its margin. The sources of bleeding from the ear in injuries to the head are fractures of the external canal and injury to the tympanic plexus, the sigmoid sinus, the jugular bulb, the middle meningeal artery and, rarely, the internal carotid artery. When bleeding is especially free it is likely to arise from one of the peripheral sinuses. When from the internal carotid artery, it is cataclysmic and usually occurs from the ear, nose and throat at the same time.

If the fracture does not reach the margin of the drum but opens into the middle ear, blood will fill the latter and produce a bluish bulge of the drum. Hematotympanum may occur with both transverse and longitudinal fractures of the petrosa.

The author reports 7 cases of fracture with bleeding from the ears; in 4 bleeding occurred immediately and in 3 at varying times after the injury, but in all there were recurrences one or more times after complete cessation of the initial hemorrhage. He cites cases reported by others of delayed hemorrhages from the ear or into the labyrinth and also of late hemorrhage into the brain. He believes that these hemorrhages are analagous to intermittent epistaxis and intermittent cerebrospinal rhinorrhea after trauma. He states that in the cases of bleeding from the nose he has seen prodromal symptoms similar to those seen with bleeding from the ear: tinnitus, deafness, headache, mental depression and rise of blood pressure. He thinks that the increased blood pressure and intracranial pressure are responsible but feels that the true explanation of late aural hemorrhage will have to await material from autopsies.

M. V. MILLER, Philadelphia.

THE CLINICAL SIGNIFICANCE AND THE TREATMENT OF OTOGENOUS FACIAL PARALYSIS. HANS BRUNNER, *Laryngoscope* **49**:276 (April) 1939.

After reviewing the clinical significance of otogenous paralysis of the facial nerve, Brunner again recommends his operation for patients in whom after one year spontaneous contraction does not develop and the electrical reaction does not show improvement.

Brunner's operation, performed endorally, aims to correct the condition only in the oral branch of the facial nerve, by sliding forward a flap of the masseter muscle beneath the mucous membrane and attaching it to the angle of the mouth. A short flap of the masseter muscle may be used, prolonged forward by catgut or a strip of fascia lata. The least risk is supposed to attend this method. Experience has shown not only that the implanted muscle flap assists mechanically but that nerve fibers grow into the paralyzed muscles from the implanted muscle, accelerating regeneration when it is possible and in all cases decreasing the disfigurement of the face.

.WOOD, Newark, N. J.

OTITIS IN DIABETES. E. H. MAIER, *Monatschr. f. Ohrenh.* **73**:305 (May) 1939.

In discussing 35 cases of otitis media in diabetic persons treated at the Vienna Otologic Clinic, the author points out what possible relations between those two diseases might exist. The number of cases is 0.9 per cent of the cases of acute otitis media treated, but it cannot be determined whether the age of the patient has any influence, nor does it appear that the type of infection is of importance. Diabetes does not increase the number of operations nor complicate the after-treatment, but the author recommends local analgesia to avoid the danger of acidosis, which may complicate general anesthesia. If a patient does not respond properly to insulin therapy, such failure may be accepted as a measure of the intensity of the suppuration and an indication that the process is still progressing. The conclusions drawn by the author are as follows: When operation is indicated the diabetic condition is no contraindication, provided that proper internal medication has been given. If there is sufficient time, the patient should be rendered free of sugar and acetone. Difficulty in regulating the diabetic state of the patient is an indication for operation, as it reveals the progress of the suppuration. In every comatous state, a spinal tap is indicated to exclude meningitis.

LEDERER, Chicago.

ROENTGEN TREATMENT OF ACUTE OTITIS MEDIA. PALLE MENCK-THYGESEN, *Pract. oto-rhino-laryng.* **2**:105 (April) 1939.

The author reports the results of roentgen therapy in the treatment of a series of 110 patients with acute otitis media. One hundred and seventy-two ears were involved.

His technic varied with the age of the patient. For those up to 2 years he used 100 roentgens with a filter of 4 mm. of aluminum; for those from 2 to 8 years, 150 r with a filter of 4 mm. of aluminum; for those from 8 years to early adult life, 200 r with a filter of 4 mm. of aluminum, and for adults, 200 r with a filter of 0.5 mm. of copper and 2 mm. of aluminum. Sixty-two of his patients required only one treatment; for 47 the treatment was repeated within eight days, and only 1 patient required three exposures. Paracentesis was done in all the cases, whenever indicated. In addition, the usual local treatment was instituted to maintain drainage and cleanliness.

The author made a comparison of a number of cases of patients treated with the ordinary routine and his group of patients treated by roentgen rays and found that in the latter 20 per cent of the patients were less likely to require operative intervention. In addition, the duration of the discharge was markedly decreased. The average length of discharge was eleven and three-tenths days. However, the latter fact was influenced by the time of institution of treatment, for he found that when treatment was started early after the onset of the infection, particularly in what he terms the presuppurative stage, his results were decidedly better. Untoward effects did not follow the treatment, and he disputes the development of such complications as falling of the hair, dermatitis or disturbance of hearing. In his series, 23 patients did not improve with treatment and had to be operated on.

In summarizing, he states that the treatment is painless, that the operative percentage is definitely lowered and that the duration of the discharge is shortened. The contraindications are fulminant progressive mastoiditis, extensive bony destruction of the mastoid cells as seen on roentgen examination or the onset of any intracranial complications.

PERSKY, Philadelphia.

#### TREATMENT OF TINNITUS AURIUM WITH HYPERTONIC SOLUTION OF MAGNESIUM SULFATE. D. IOANNOVICH, *Pract. oto-rhino-laryng.* 2:114 (April) 1939.

In his discussion of tinnitus aurium, the author classifies its causes as either general or local. The general causes may be vasomotor, organovascular, contagious or toxic. The local causes, which may be intralabyrinthine or perilyabyrinthine, may be dystrophic, inflammatory, neoplastic or degenerative. Tinnitus caused by vasomotor and vascular disturbances may be associated with headache and may be due to an increase in pressure in the perilymphatic spaces, usually the result of an increase of pressure in the posterior fossa.

In the latter group of cases, he injects intravenously 5 cc. of a 50 per cent solution of magnesium sulfate, slowly. The results of this type of therapy are rather striking, particularly for hypertonic persons.

His series of 50 cases is divided into the following groups: (1) cases in which evidences of circulatory vasomotor disturbance appeared without any apparent organic disease, in which group he obtained either improvement or cure in every case; (2) cases of arteriosclerosis; (3) cases in which the condition was associated with or followed frank disease of the middle ear; (4) cases of otosclerosis, in which group, of 6 cases reported, he showed improvement or cure in 4, and (5) cases of neurosis, in which group he had improvement or cure in 60 per cent of cases. Summarizing all groups, he found cure in 26 per cent and improvement in 40 per cent of cases, but, if he were to eliminate the group in which disturbances of conduction had occurred, then he would have had cure in 31 per cent and improvement in 48 per cent.

In conclusion, he recommends this technic as a harmless procedure but valuable in cases of tinnitus, particularly tinnitus due to vasomotor or vascular disturbances in or about the labyrinth. It was in this group that he obtained favorable results in 100 per cent of cases.

PERSKY, Philadelphia.

## Pharynx

TUBERCULOSIS OF TONSILS. H. M. POLLARD and A. B. COOMBS, *Am. Rev. Tuberc.* **38**:746 (Dec.) 1938.

Among a carefully followed group of 107 children in whom tuberculosis of the tonsils was demonstrated active pulmonary tuberculosis developed during post-operative observation in 3, tuberculosis of the cervical lymph nodes in 1 and tuberculosis of the spine in 1. More complete examinations after the finding of tuberculous tonsils revealed that 9 of the children had had pulmonary tuberculosis and 3 tuberculosis of the mediastinal lymph nodes at the time of operation. Twenty children who had tuberculosis other than of the tonsils and adenoids at the time of operation did not subsequently acquire an additional lesion. Seventy patients with tuberculosis limited to the tonsils and adenoids remained free from tuberculosis or any other illness subsequently. It seems, therefore, that in patients in whom tuberculous infection is limited to the tonsils the disease rarely develops elsewhere. Careful postoperative examinations should be made of all patients with such local infection, however, and if evidence of disease is found elsewhere, the patients concerned should be kept under observation.

EUGENE H. SMITH, Ogden, Utah. [*AM. J. DIS. CHILD.*]

ROENTGEN TREATMENT OF THE TONSILS. BENASSI and M. SCARZELLA, *Rev. franç. de pédiat.* **14**:170, 1938.

Twenty-six cases are reported in which patients with diseased tonsils were given roentgen treatment in preference to tonsillectomy. In all, the tonsils became smaller and more normal in appearance, and the clinical improvement in the general condition compared favorably with that following tonsillectomy. The authors emphasize that roentgen treatment acts primarily on the infected, hypertrophied tissue and does not destroy the normal lymphatic tissue. They also state that the radiation stimulates the histiocytic response and so mobilizes forces combating infection. The details of the roentgen technic are given.

LESLIE, Evanston, Ill. [*AM. J. DIS. CHILD.*]

HEMORRHAGES AFTER TONSILLECTOMY. E. G. OSER, *Monatschr. f. Ohrenh.* **73**: 112 (Feb.) 1939.

The writer has observed among 12,241 tonsillectomies, 93 postoperative hemorrhages (0.75 per cent). A total of 3,121 operations were performed with the patient under local analgesia, with 65 postoperative hemorrhages (2 per cent), and 9,120 operations with the patient under general anesthesia were accompanied by 28 postoperative hemorrhages (0.3 per cent). Among 7,303 adenoidectomies he has observed but 3 postoperative hemorrhages. From these figures it follows that the danger of postoperative hemorrhages in general is greater in tonsillectomies performed under local analgesia than in those performed under general anesthesia. The author further states that this danger is generally greater in adults than in children and that, as far as the adenoidectomies are concerned, it is diminished to a great extent if the epipharynx is examined by palpation after the operation for remains of adenoid tissue.

LEDERER, Chicago.

## Larynx

POSTURAL TREATMENT OF ACUTE LARYNGOTRACHEOBRONCHITIS. T. C. GALLOWAY, *J. A. M. A.* **112**:1566 (April 22) 1939.

Galloway discusses acute laryngotracheobronchitis in fair detail, stressing certain points in the differential diagnosis, as well as the pathologic processes of all of the structures, including the mechanical phases, the pathologic functions and the clinical features resulting therefrom. He quotes freely from the recognized authorities.



The cases of 10 patients in his service, 2 of whom died, constitute the central theme about which the discussion is woven.

He emphasizes the use of tracheotomy when indicated but enlarges on the postural treatment of acute laryngotracheobronchitis. The technique, cited from Morlock, is as follows: The foot of the bed is elevated at least 15 degrees and more if the patient will tolerate it. "In children the prone position with the foot of the bed raised provides a much better gradient and it is usually accepted easily." It is important that the fluid elements in the respiratory tree be of such consistency that they flow readily to the areas of greater cough reflex, where the tussive squeeze and cough may aid in the expulsion, postural drainage aiding not a little.

Lavage of the respiratory tract is moderately discussed. The author summarizes his therapy by outlining in full every means thus far known which he has used in his series of cases toward the attainment of best results for acute laryngotracheobronchitis.

GORDON, Philadelphia.

SUBGLOTTIC DIPHTHERIA, INITIATED BY SUDDEN ASPHYXIA, SIMULATING THE PRESENCE OF A FOREIGN BODY IN THE LOWER RESPIRATORY TRACT. C. RICCI, *Arch. ital. di otol.* **51**:157 (April) 1939.

Ricci reports the case of a child aged 14 months, apparently in perfect health, who, while eating supper, consisting of meat with fragments of cartilage and bone, suddenly became dyspneic, coughed violently and was cyanosed. Examination revealed almost complete immobility of the left lung without alteration in the voice or the cough. Direct laryngotracheoscopic examination revealed only slight congestion of the pharyngeal and laryngeal mucosa. Owing to the alarming condition of the child, immediate tracheotomy was done, after which the left lung immediately began to function and the cyanosis and distress were relieved. Respiratory difficulty recurred the following morning, together with profuse sweating, a rapid pulse rate, moderate cyanosis and rise of temperature. A roentgenogram revealed bronchopneumonia in the apex of the right lung. Death occurred seventeen hours after the onset. Autopsy revealed a diphtheritic membrane on the lower surface of the vocal cords and subglottic region, the presence of streptococci and Loeffler's bacilli and fatty degeneration of the liver, spleen and myocardium. The location of the diphtheritic membrane explains its oversight during the direct examination. It is assumed that the atelectasis was caused by toxic spasm of the left bronchus. Instances of diphtheria simulating a foreign body in the respiratory tract are rare; more common are cases of a foreign body simulating croup. The diagnosis in such cases is usually made late or at the autopsy table.

DENNIS, San Diego, Calif.

## Nose

BEHAVIOR OF THE DIENCEPHALIC AND EXTRADIENCEPHALIC NEUROVEGETATIVE SYSTEMS IN CASES OF SINUSITIS. C. PORTA, *Arch. ital. di otol.* **51**:163 (April) 1939.

Porta studied the changes in the hypophysis and diencephalon in 8 cases of inflammation of the posterior group, and in 12 cases of inflammation of the anterior group, of nasal sinuses. The report of the clinical study is preceded by a discussion of the structure and function of the region and by the details of an experimental study of rabbits subjected to chemical inflammation of the nasopharynx. The results of the animal experimentation were that after cauterization of the pharyngeal vault extended over months distinct pathologic changes occurred in the hypophysis and diencephalon (hypothalamus).

In patients with inflammation of the posterior sinuses, the investigation included examination of the psyche, the habits of sleep, the basal metabolism, the

exchange of water, carbohydrates and fats, the elimination of chlorides, the vasopressure system of the blood, the thermoregulator system and the sexual apparatus, investigation of polyphagia and general physical and roentgenographic examinations. In patients of the second group, the examination of the extradiencephalic system included study of the photomotor reflex, Negro's reflex, Much's reflex, the nasolacrimal, nasovasodilator, oculocardiac, sudoral and pilomotor reflexes and dermatographism. In addition, pharmacodynamic tests with epinephrine and amyl nitrite were undertaken.

The research showed indubitably that both the diencephalic and the extradiencephalic, vegetative nervous system are altered by neighboring infectious processes, sinusitis playing a role of great importance. These changes produce dysfunction, represented in the first group by psychic syndromes (emotivity and suggestibility and sometimes hysterical manifestations), disturbed sleep (hypersomnia and dissociation of sleep into its component parts), polyuria and polydipsia or oliguria, changes in the blood (increase of red cells, leukocytosis, deviation to the left in Arneth's formula and hyperglycemia), variations in temperature and adiposogenital dystrophy. In the second group were observed increase of the nasolacrimal and nasovasodilator reflexes, changes in the oculocardiac reflex, a positive reflex of Much, dermatographism with increase of the permeability of the capillaries, Claude Bernard's syndrome and the sphenopalatine syndrome. Ethmosphenoid sinusitis causes disturbances in the diencephalon and less so of the extradiencephalic nervous system. Inflammation of the anterior ethmoid and maxillary sinuses affects by preference the sphenopalatine system. Isolated frontal sinusitis rarely causes disturbances of the neurovegetative system.

DENNIS, San Diego, Calif.

A CASE OF PROBABLE NASOMAXILLARY LUPOSYPHILITIC HYDRIDISM. G. SAIBENE, Arch. ital. di otol. **51**:201 (April) 1939.

The patient described by Saibene was a girl aged 12 years who had a destructive, ulcerating lesion located in the nasal vestibule and involving the bone of the septum and the maxilla. The preliminary diagnosis was lupus. Appropriate treatment being inefficacious the presence of syphilis was suspected, and a Wassermann test gave positive results. Antisyphilitic medication caused prompt and rapid recovery.

The author discusses the etiologic diagnosis at length. In favor of lupus were the hypertrophic vegetating character of the ulceration, with rosy gray nodules, and the discovery in the biopsy material of tuberculous granuloma and acid-fast bacilli. The deep-seated involvement of the bone and the prompt improvement following antisyphilitic treatment indicated syphilitic participation. The failure of the patient to react to the tuberculin test does not invalidate the diagnosis of lupus, since it has been shown by Tarentelli and others that anergia to tuberculin may be present in patients with late syphilitic manifestations and a strongly positive Wassermann reaction. The improvement in the tuberculous element in the lesion, along with the syphilitic component, is explained by increase in the general bodily resistance, induced by the antisyphilitic treatment.

DENNIS, San Diego, Calif.

SINUSITIS IN ALLERGIC PERSONS. WILHELM SCHOLZ, Ztschr. f. Hals-, Nasen- u. Ohrenh. **45**:14 (March) 1939.

The author discusses the role of polypi in sinusitis and believes that they are usually of an allergic origin. Ordinarily, the pathologic conditions found in a sinusal infection, such as polypi and granulations, rapidly give way to a normal status after a thorough and proper radical operation. However, when this does not occur readily an allergic influence can be assumed, to determine which it is necessary to make a detailed study of the nasal secretions and the blood smears

for eosinophilia. In addition, other allergic studies should be made, such as cutaneous testing, the control of the blood picture by injections of splenic extract and the determination of the potassium-calcium quotient.

The author states that often there may be a marked increase of eosinophils in the blood during an attack of hay fever or vasomotor rhinitis but that there may not be any marked changes in the mucous membrane of the nose, such as edematous polyposis. On the other hand, during the height of an asthmatic attack, there may also be a marked decrease of eosinophils in the blood.

In discussing the therapeutics, the author expresses the opinion that the removal of every possible focus of irritation is important. Proper ventilation of the sinuses must be established. Calcium, given either intramuscularly or by mouth, in combination with phosphorus, is usually beneficial. Perhaps most important is the dietary control, and he recommends a purely vegetarian diet as ideal. He also recommends the cauterization of both the inferior and the middle turbinate with trichloroacetic acid.

PERSKY, Philadelphia.

ABCESS OF THE NASAL SEPTUM OF DENTAL ORIGIN. M. LACROIX and KARAITIDIS, *Oto-rhino-laryng. internat.* **23**:169 (April) 1939.

Odontogenous abscess of the septum is rare; only some 30 cases were culled from the French and foreign literature by Terracol in 1937. Various opinions of the pathway of the infection from the tooth to the septum have been expressed, the most probable course being by continuity of tissue.

Two cases are reported, both patients being in their teens. In the first patient, the source of the infection was a perialveolar abscess; in the second, it was a periapical focus. The connection between the dental and the septal abscesses was established by passing a probe from one to the other and then taking a roentgenogram.

DENNIS, San Diego, Calif.

### Miscellaneous

ETIOLOGY OF CHOREA: ITS RELATION TO RHEUMATIC FEVER AND HEART DISEASE. S. J. USHER, *Canad. M. A. J.* **39**:565 (Dec.) 1938.

Usher presents the results of his study of 105 patients who were admitted to the rheumatism pavilion of the Children's Memorial Hospital of Montreal for treatment of chorea. In 56 the condition was purely chorea; i. e., the patients showed no rheumatic symptoms. In 49 chorea was mixed with rheumatic symptoms.

If the patients with infected tonsils and repeated infections of the upper respiratory tract were omitted from the group with pure chorea, only 14 per cent showed evidence of endocarditis. In the group with chorea and rheumatic symptoms 65 per cent showed heart disease.

Usher believes that valvular heart disease in patients with chorea is due not to the chorea per se but to intercurrent attacks of polyarthritis or severe infections of the upper respiratory tract associated with infection of the tonsils. He believes also that more should be made of psychic disturbances, removal of which will do more to prevent recurrences than removal of foci of infection.

MOORE, Omaha. [*AM. J. DIS. CHILD.*]

OTOLARYNGOLOGIC SUGGESTIONS IN PEDIATRIC PRACTICE. H. DINTENFASS, *Pennsylvania M. J.* **42**:226 (Dec.) 1938.

*Acute Sinusitis and Acute Rhinitis.*—In the treatment of these conditions pediatricians should remember that the prime object is to assist nature. Recalling that the three lines of defense against infection are (1) the mucous film, (2) the ciliated epithelium and (3) the highly vascular submucosal stroma, one should employ remedial measures which do not disturb the function of these defense

mechanisms. Local treatment of the nose should be mild and nonirritating. It can safely be said that the less intranasal treatment the better. Ephedrine and other shrinking solutions, while they produce temporary relief from nasal stuffiness, have the great disadvantage of causing secondary relaxation of the vascular layer of the submucous tissue, with resultant boggiess of the turbinate structure, interference with the normal flow of mucus and disturbance of ciliary movement.

*Acute Otitis Media.*—A knowledge of the anatomic variations and peculiarities of the middle ear of the infant and the young child is essential in a consideration of the subject. The eustachian tube in the infant is unusually short and wide and more horizontally placed than in the adult, accounting for the frequency of middle ear and mastoid disease secondary to nasal infection. In the infant there is no bony canal; the inner end of the membranous canal is attached directly to the rim of the drum head. Moving the auricle, therefore, in the presence of acute otitis media is productive of pain.

Paracentesis of the tympanic membrane should be done if despite conservative measures pain or restlessness continues for more than twenty-four hours in association with bulging or reddening of the drum head with or without fever. The contents of the middle ear should never be left to perforate spontaneously. The patient is put to bed and kept there until the ear becomes perfectly dry. It is a good rule that under no circumstances may a patient be up and about when there is an acute discharge from the ear. If these instructions are adhered to, the possibility of mastoid involvement is lessened.

LOGUE, Williamsport, Pa. [AM. J. DIS. CHILD.]

"APHASIA" IN A PARTIAL DEAF-MUTE. MACDONALD CRITCHLEY, *Brain* **61**:163, 1938.

Hughlings Jackson suggested that focal cerebral lesions may damage or destroy the execution of sign language by a deaf-mute. Critchley reports a case in which strong support is furnished for Jackson's contention, although complete proof is lacking.

A man aged 42 had been well until the age of 7, when he gradually lost his hearing and was taught finger spelling. At 14 he was stone deaf and was admitted to an institution for deaf-mutes, where he was taught lip reading. After leaving the school he relied chiefly on manual signs and finger speech to communicate with others. Paralysis developed on the right side, and for three days he was deprived of what little articulate speech had previously been possible to him. Paralysis, like speech, improved to a certain degree. As soon as he was able to hold a pen it was found that he could neither write nor perform on paper simple arithmetic calculations. He could no longer read lips. For a few days after the stroke he was unable to understand people who communicated with him by finger spelling. The ability returned in a few days, but he was still unable to reply on his hands. Articulate speech was infrequent and considerably altered. Speech was dysarthric and ungrammatical; he seemed to rely little on this means of communication. He remained under observation for the next two years, during which his condition changed little, if at all.

No similar case is recorded in the literature. Grasset (1896) reported the case of a deaf-mute who lost his ability to make hand signs after a cerebral vascular lesion. The patient was able to read with understanding and to comprehend finger talk in others. He was unable, however, to reply in the finger alphabet with the right hand, but could do so with the left. Grasset concluded that in the deaf-mute a center for manual speech develops in the cortex, independent of the motor area of the upper limb. He located this tentatively at the foot of the second frontal convolution of the left hemisphere.

In Critchley's case, the natural sign language was not impaired. The circumstances were unusual, however, in that the patient had never been proficient in this means of communication and preferred lip reading or finger spelling. This may be ascribed to a variety of reasons, especially to the fact that hearing was intact for the first few years of life, during which articulate speech developed normally. For this reason, the patient cannot be regarded as having "complete" or congenital deaf-mutism. Hughlings Jackson's surmise therefore remains unverified, as it referred explicitly to a natural system of signs and not to finger spelling. It is justifiable to suggest that a much more severe lesion would be required to abolish the primitive sign language than the elaborate system of dactylology.

SALL, Philadelphia. [ARCH. NEUROL. & PSYCHIAT.]

CAUSE OF PARALYSIS IN DIPHTHERIA. I. TAYLOR, Brit. J. Child. Dis. **35**:250 (Oct.-Dec.) 1938.

Taylor discusses some of the evidence bearing on the manner in which diphtheria toxin attacks the nervous system. The view held by some authors is that all forms of diphtheritic paralysis are due to hematogenous toxemia, the frequency with which certain nerves are attacked being explained by the selective affinity of the toxin for these nerves. The close anatomic relation between the site of infection and the initial paralysis has led other observers to discard this theory in favor of different views. They state that the toxin first attacks the nerves in the locality of the site of infection and that all other paralyses are produced by diffusion of toxin in the nervous system from the point of entry. This view receives some support from the orderly sequence of paralyses commonly noted in faucial diphtheria. The two schools of thought meet in the theories advanced by Walshe, (1) that the initial paralysis is caused by lymphogenous invasion of the nervous system, the toxin passing from the site of infection to the central nervous system by the perineural lymphatics, (2) that generalized paralysis is the result of hematogenous toxemia and (3) that paralysis of accommodation is the result of the selective affinity of circulating toxin for certain elements of the nervous system. Most clinicians and experimental workers are agreed that the late multiple neuritis following diphtheria, giving rise to diphtheritic pseudotabes, is due to hematogenous toxemia. The strongest evidence of the hematogenous origin of such paralyses is the fact that the experimental injection of diphtheria toxin intravenously into animals produces a multiple neuritis which is exactly comparable with this late form of peripheral neuritis accompanying diphtheria in the human being. In addition to paralysis of the limbs, paralysis of accommodation must be included in the group of symptoms due to blood-borne toxin, because this form of paralysis is found frequently in both faucial and extrafaucial diphtheria. There are good grounds for believing that hematogenous toxemia is capable of producing, in addition to generalized paralysis, a type similar to the local paralysis found in faucial diphtheria. The author believes that one may thus accept the possibility that blood-borne toxin may play a part in the production of local paralyses encountered in faucial diphtheria. The close anatomic relation between the local paralysis and the site of infection can leave no doubt that the nervous system is primarily attacked by local absorption of toxin. Unilateral faucial diphtheria frequently results in paralysis of the corresponding side of the palate. An important and familiar clinical observation is what has been described as the "march of paralysis." One cannot but be impressed by the orderly way in which paralysis develops in most severe forms of the disease, palatal paralysis preceding pharyngeal and the diaphragm being involved before the intercostal spaces. Such a march suggests the slow spread of toxin in the central nervous system.

J. A. M. A.

SOME ETIOLOGIC FACTORS IN THE PATHOLOGY OF STAMMERING. I. LATIF, Brit. J. M. Psychol. 17:307 (Dec.) 1938.

Latif finds that claims to one universal treatment in all cases of stammering are not justified by actual results and that, whereas some disorders of speech yield to one kind of treatment, a large number of patients remain unaffected by it. The author attempts an analysis of a few etiologic factors in the onset and cure of stammering by presenting 2 sample cases from his clinical investigations. These cases illustrate that the causes of stammering and its treatment vary from one case to another. The first case shows that although stammering may have its inception in the factors (fear of parents, sense of guilt because of masturbation, inferiority, imitation and fear of a stammering heredity) which may be regarded as more or less primary, other conditions, such as lack of steady control over breathing and voice and faulty habits of reading, may further complicate the etiologic factors in the disorder during the course of its development. Consequently, no therapeutic measure can be really effective unless, with the primary factors, it takes into account secondary conditions. Besides the analysis of the second patient's difficulties (which were similar to those of the first) when he was in a state of relaxation, the author also tried a few exercises of musical drill with him. In addition to this, he assigned a few tasks requiring delicate handling of instruments in the laboratory in order to help the patient overcome his sense of inadequacy in manual skill. The period of treatment lasted eleven months, after which the patient was completely cured. Oral or phonetic exercises were not resorted to during the entire course of treatment.

J. A. M. A.

ASSOCIATION OF STAMMERING AND THE ALLERGIC DIATHESIS. A. M. KENNEDY and D. A. WILLIAMS, Brit. M. J. 2:1306 (Dec. 24) 1938.

Kennedy and Williams examined a consecutive series of 100 children who stammered. These children were from 5 to 14 years of age. Of the children examined, 81 were boys and 19 girls; 89 proved to be right handed and 11 left handed, and 65 gave a family history of stammering and 35 no such history. Fifty-two children gave a personal history of allergic manifestations: Thirty-two complained of migraine alone or in combination with urticaria and/or asthma or with asthma plus eczema; 11 complained of urticaria alone; 8 had a history of asthma alone or combined with eczema and/or hay fever, and 1 suffered only from eczema. Thirty of these 52 children also gave a history of "fastidiousness" with regard to food generally and dislikes or refusals of particular foods or gastrointestinal upsets after them. Of the 52 children with a personal history of allergy, 48 also had a family history of allergy. In 37 cases one or both parents exhibited allergic manifestations, and in 6 a grandparent, in 4 an aunt and in 1 a sister was the nearest sufferer. Thirty-three of the 52 children (including the 4 with no allergic family history) had a family history of stammering. Seven of the 52 children were left handed; 6 of these 7 had a family history of allergy and 2 also a family history of stammering. Of the 48 children who did not give a personal history of allergic manifestations, 47 had a family history of allergy. Fifteen of these children, however, gave a history of "fastidiousness" with regard to food generally and dislikes or refusals of particular foods or gastrointestinal upsets after them. In 37 of the 47 cases one or both parents suffered from allergy; in 5, a grandparent; in 2, an aunt, and in 3, a sister. Thirty-two of the 48 children (including the one with no allergic family history) had a family history of stammering. Four of the 48 children were left handed, and all 4 had an allergic family history. Three also had a family history of stammering. The close and practically constant association of stammering and allergic manifestations in the personal and family histories of the stammerer revealed by the present investigation favors the view that there is something more than a casual relation between stammering and the allergic diathesis.

J. A. M. A.

ESSENTIAL NEURALGIA OF THE FACIAL NERVE. CARLOS CHARLIN, *Ann. d'ocul.* **175:894** (Dec.) 1938.

Persistent neuralgia of the facial nerve of unknown cause which is resistant to all treatment and lasts for many years and sometimes for a lifetime is frequent. Both etiologic research and symptomatic therapeutics have been without avail. Most patients with this type of neuralgia are submitted time and again to anti-syphilitic treatment, to protein therapy of many kinds, to removal of teeth and to nasal operations, without relief. Neurologic investigation generally shows idiopathic neuralgia to be one of five types: (a) essential neuralgia of Sicard, (b) sympathetic neuralgia, (c) cyclic neuralgia, (d) causal neuralgia and (e) secondary neuralgia. The cause of the last type also is unknown.

Observations on the first 50 patients are summarized. All of them were given neurologic, medical, ophthalmic, otorhinolaryngologic, dental and phthisiologic examinations before treatment was started. Phthisiologic observations on the first 40 patients only are analyzed. Of this series, 18 had a tuberculous history; tuberculous lesions were found at the site of the neuralgia in 10, and 31 had thoracic bacillary lesions, which were clinically active in 5. Improvement was noted in most of the patients after tuberculin therapy, bacteriologic treatment and specific therapy.

S. H. MCKEE. [ARCH. OPHTH.]

MORPHOLOGY OF EPULIS. L. GERY and O. NOEPPPEL, *Bull. Assoc. franç. p. l'étude du cancer* **27:137**, 1938.

Gery and Noeppel define epulis as a sessile or a pedunculated outgrowth of the gum, originating from its soft tissue. They studied 240 such growths seen between 1919 and 1937 at the Institute of Pathology in Strasbourg, France, and found 230 of them to be hyperplastic tumors of the mesenchyma or, rarely, of the alveolodental ligament. All were benign, though some recurred locally. Histologically they could be divided into four not sharply separated groups: the inflammatory, the vascular or angiomatous, the fibrous and the giant cell group. Transitions among them were so frequent that a histologically homogeneous form was rare. The inflammatory epulis consisted of granulation tissue rich in blood vessels and in an exudate that sometimes was leukocytic but often plasmocellular. The vascular epulis showed excessive formation of blood vessels, which lacked the regularity and arrangement that are characteristic for granulation tissue. The fibrous epulis was made up predominantly of fibroblasts with varying amounts of intercellular fibers. Two types of cells determined the giant cell epulis: a small mononuclear cell resembling a fibroblast but easily differentiated from it and the well known multinucleated giant cell, similar to the bone marrow giant cell. The small cells, which could be shown to be connected with each other by means of protoplasmic outgrowths, are considered by Gery and Noeppel to be the fundamental unit of the growth. The hypotheses concerning the formation of the giant cells are discussed in detail. Their mesenchymal origin and lack of any relation to the bone marrow giant cells are emphasized, and the name "histioplaxe" is suggested for them. In all the forms of epulis, deposits of collagenous masses were found, as well as ossification. The latter is explained as the function of the histiocyte in the sense of Maximow's polyblast. The deposition of calcium in the preformed osteoid tissue, as well as calcification without formation of bone, is brought into relation with the observation that not infrequently decalcification of the alveolar process was recorded, with transport of calcium, much as in the formation of calluses. New-formed cartilage was observed rarely. The authors emphasize the evidence against the origin of the epulis from bone. In their opinion, the epulis is formed by the reticulum in response to an unknown irritating factor. The histiocyte, with its formative potentialities, is fully capable of explaining the morphologic variations of the epulis and the frequent observation of phagocytosis.

I. DAVIDSOHN. [ARCH. PATH.]

GLOSSOPHARYNGEAL NEURALGIA—RECURRENCE AFTER INTRACRANIAL SECTION OF THE NERVE. W. S. KEITH, *Confinia neurol.* 1:345, 1938.

Keith reports the case of a woman aged 75 who complained of terrific attacks of pains just in front of the left ear. The pains were preceded by sudden twisting sensations in the left side of the throat and were brought on by swallowing. The left glossopharyngeal nerve was divided, with complete relief from symptoms. Two years later the patient again felt slight pains in the left side of the neck, and four months later a major attack occurred. The upper half of the vagus root and the nerve of Wrisberg were divided, and this was followed by complete freedom from attacks.

DE JONG, Ann Arbor, Mich. [ARCH. NEUROL. & PSYCHIAT.]



# Society Transactions

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## CHICAGO LARYNGOLOGICAL AND OTOLOGICAL SOCIETY

GEORGE T. JORDAN, M.D., *President*

*Regular Monthly Meeting, Oct. 2, 1939*

### Pathologic Changes of the Inner Ear in a Case of Deafness from Epidemic Cerebrospinal Meningitis. Presented by DR. ELMER W. HAGENS.

A fatal case of epidemic cerebrospinal meningitis is reported, in which deafness occurred forty-six days before death. The temporal bones were obtained, and microscopic examination of the labyrinths was made. The observations support the reports in the European literature of severe, bilateral destructive labyrinthitis, with tendency toward healing in the form of granulation tissue and bone. The end organs were practically destroyed and demonstrated why permanent total or nearly total loss of cochlear and vestibular function occurs.

Five weeks prior to admission to the hospital, the history stated, in a 3 year old boy high temperature, projectile vomiting and coma lasting about one week developed. On recovery it was noted that he could not hear. About eight days before admission high temperature again developed. At the hospital it was found that the neck was rigid; the Kernig, Brudzinski and Babinski signs were positive. Spinal puncture revealed increased pressure and cloudy fluid with 850 cells and a 2 plus reaction to the Pandy test, which, on culture, was shown to contain meningococci. In spite of administration of antitoxin intravenously and general supportive measures, the child's condition became worse, and death occurred about forty-six days after deafness was noted. During the hospitalization otitis media was not noted. A general postmortem examination showed suppurative leptomeningitis (epidemic type), focal bronchopneumonia, severe parenchymatous degeneration of the myocardium, kidneys and liver and infectious hyperplasia of the spleen.

The slides illustrate a microscopic study of both temporal bones. Apparently there had been a diffuse suppuration of the labyrinths. At the time of death the process had undergone resolution, and granulation tissue had filled in a considerable portion of the labyrinth. Destruction of bone had occurred about the semicircular canals, but only moderate evidence of bone building was observed. In the right ear the spiral ganglion and the organ of Corti were practically destroyed; the vestibular organs also were missing, although the Scarpa ganglion was intact. In the left ear the spiral ganglion was present, and a distorted organ of Corti was seen in the basal coil. The vestibular end organs were recognized but were no doubt functionless. Both divisions of the eighth nerve were present in the internal auditory meatuses of the two ears, but the number of polymorphonuclears along the nerve tissue pointed to the spread of the infection to the labyrinths along this pathway. Some mononuclears and polymorphonuclears were noted also in the aquaeductus cochleae. The fossa for the oval and round windows and the pneumatic spaces showed moderate infection; no pathway from these regions to the labyrinth was noted. The connections from the semicircular canals to the tunica propria of the pneumatic spaces were doubtless due to destruction of bone by the labyrinthitis. The drum membranes and remaining parts of the middle ear were destroyed at autopsy and were therefore not observed.

Politzer discussed this subject, but, because of the scarcity of reports in the American literature, it is believed worth while to record this case.

## DISCUSSION

DR. JOHN R. LINDSAY: The sections which Dr. Hagens showed are excellent illustrations of the changes which occur in the labyrinth when there is invasion from the meninges. Temporal bones from such cases are not easily found, and therefore reports in American literature have been scarce or absent.

I have had the opportunity of examining several specimens of Professor Nager's collection in which the meningitis had occurred many years before death, and in most of these the labyrinthine spaces had been completely obliterated by formation of new bone. The question comes up, then, whether the lesions described by Dr. Hagens, if the patient had survived, would have gone on to extensive ossification and obliteration of the labyrinthine spaces with complete loss of function or whether this might have been one of the cases in which some vestiges of function remain.

Until recent years the meningococcus has been responsible in most cases for total or subtotal loss of hearing due to meningitis. Now that some cures of streptococcic and pneumococcic meningitis are being obtained, total deafness is likely to appear in some of the cases. I had the privilege of examining 1 patient so afflicted last year.

There is good reason to believe that labyrinthitis from meningococcic meningitis behaves in essentially the same way as labyrinthitis from streptococcic or pneumococcic meningitis, and I have more than 60 bones affected with the latter condition in my collection. I have selected a few slides to show some of the early steps in the invasion of the labyrinth from the meninges and also some of the later observations in cases of labyrinthitis of long standing.

Slides 1 and 2 illustrate a collection of pus at the mouth of the aquaeductus cochlearis; slide 3, invasion of the scala tympani through the mediolus; slide 4, healed labyrinthitis, showing new bone and connective tissue in the scala vestibuli and scala tympani and marked dilatation of the ductus cochlearis; slide 5, a section through the basal coil near the round window, showing bone overlying the mouth of the aquaeductus cochlearis.

DR. ALFRED LEWY: I should like to report a case which was somewhat parallel to that of Dr. Hagens, although histologic evidence is not available. The patient was a girl aged 7 who entered Cook County Hospital with frank meningitis from which the hemolytic streptococcus was cultured on three or four occasions, after otitis media on the right of about two weeks' duration. The left ear was totally deaf, with no response to caloric stimulation. Dr. Leshin did simple mastoidectomy, uncovering the dura on the right side. On the left side a radical operation was done, with no signs of infection of either the middle ear or mastoid cells. As the patient had had good hearing prior to this, it was believed that the destruction of hearing in the left ear was due to involvement of the inner ear or the nerve by meningitis originating from the right ear, due to *Streptococcus haemolyticus*. The patient recovered but for months afterward was unable to walk steadily in the dark. That was about two years ago, and she still shows some mental instability and is easily fatigued and able to attend school only part time.

DR. FRANK NOVAK: I should like to ask Dr. Hagens whether the cochlear involvement preceded the vestibular.

DR. HOWARD BALLENGER: I should like to ask Dr. Hagens whether when he looked up the literature he found the pathologic picture in any of the cases that of meningoneuritis rather than labyrinthitis. One sees frequently in infectious conditions such as mumps and scarlet fever, with or without involvement of the middle ear, what is presumed to be meningoneuritis rather than septic labyrinthitis. Patients with neuritis would be more likely to have marked partial deafness than to be totally deaf. The static branch to the labyrinth may or may not be involved. Some cases of marked deafness in meningococcic meningitis may be this type. Such reports as Dr. Hagens has just made offer the only way to settle the question.

DR. ELMER W. HAGENS: I cannot answer Dr. Novak's question—I could not tell whether the cochlea was involved first. I could not tell from the sections and did not have the history. I never saw the child and was given what history there was by the resident.

With reference to Dr. Ballenger's question, I have always wondered what the pathologic picture is in such cases. I have read of, but never observed, such a case. When the 5,000 children were examined I wondered just what the pathologic picture was and determined that if such a case were ever available I would follow it up and see what the labyrinths showed. In this case there is destruction of the organ of Corti and loss of spiral ganglion cells in one ear and partial loss in the other. Scarpa's ganglion cells were intact in both ears. I did not look up the literature completely. I do not recall a statement that the pathologic picture was that of neuritis only. As a rule neurolabyrinthitis is mentioned, and I think from the case I have and from what I found in Politzer's discussion that this designation is accurate.

**Surgical Treatment of Cancer of the Larynx.** Presented by DR. CHEVALIER L. JACKSON, Philadelphia.

Surgical treatment has the best statistical results to show in the therapy of cancer of the larynx, but in certain cases the patient may be permitted a choice, or the laryngologist may feel justified in advising irradiation. The ultimate prognosis will be best in the better differentiated, slower-growing, "lower grade" tumors, regardless of the method of treatment. "Grading" should be taken into consideration in selection of treatment, particularly in borderline conditions, and the less differentiated "higher grade" tumors should incline one toward more radical surgical intervention or irradiation, although in such cases prognosis is poor with any method of treatment.

*Surgical Indications.*—1. Lesions occupying the middle third of one vocal cord are suitable for the operation of laryngofissure by the "clipping" technic, regardless of histologic character or grading. 2. Lesions reaching the anterior commissure and even involving the opposite cord are amenable to extirpation by laryngofissure also, but in such cases the Chevalier Jackson "anterior commissure" technic should be used. 3. Lesions in which the growth is chordal but has reached the posterior end of the cord and produced impairment of motility or has extended subglottically call for total laryngectomy.

Laryngectomy and pharyngotomy are done also when the lesion is "extrinsic," but the results in such cases are unsatisfactory, and it is possible that irradiation would accomplish as much in arresting the growth and prolonging life. On the other hand, for some of the extensive lesions, especially for those with involvement of cartilage or perichondritis, there may be some advantage in removing the larynx as a preliminary to irradiation.

The indications for and technic of laryngofissure and laryngectomy as carried out at Temple University Clinic are given in detail, and voice and speech instruction follow operations on the larynx.

#### DISCUSSION

DR. PAUL HOLINGER: I know that all members of this society appreciate the vast experience that has given the significant conclusions which Dr. Jackson presented on this highly controversial subject.

I was glad Dr. Jackson stressed the necessity of biopsy in spite of the fact that his paper dealt only with treatment. Certainly the grading of the lesion is an extremely important factor in the choice of therapy, to say nothing of the importance of biopsy in establishing an accurate diagnosis.

The extremely interesting question of the voice after operations on the larynx was beautifully illustrated with the sound motion picture film. There is a great danger, however, of attempting to rationalize in the choice of a surgical procedure in an effort to give the patient a good voice. This is usually only wishful thinking, dangerous not only to the patient but also to the final statistical analysis

of the merits of the various procedures. If laryngologists could adhere strictly to the indications Dr. Jackson stressed, possibly their series of permanent cures could approach the 85 per cent he reported for suitable cases.

One question I should like to ask deals with work being carried out at Temple University by Drs. Fay and Smith. Has any experimental work been carried out in refrigeration to relieve the pain of far advanced extrinsic carcinomatous lesions of the larynx?

DR. FRANCIS LEDERER: A year ago this society opened its season with a similar discussion of cancer of the larynx, and at that time I had occasion to speak about rehabilitation of the voice and showed a number of examples. I have not been so fortunate as Dr. Jackson in getting the perfect voice he demonstrated in his patients after laryngofissure. Perhaps my patients have not used the ventricular bands as much as his have. It is a startling and excellent result.

I have always been interested in the rehabilitation of the voice after laryngectomy, because it would be a severe jolt to a patient if one could not promise any voice. On previous occasions the opportunity has been offered to observe patients who have developed a buccoesophageal voice after laryngectomy by their own efforts, and the value of instruments that are made to give the patient an artificial voice has been demonstrated. I wish to introduce—apologetically, because I feel personally grateful to the Western Electric Company for their efforts in making the artificial larynx, having in mind that patients have not universally responded well to it—an apparatus which Dr. Jackson has seen before, demonstrated by its originator, who himself is a laryngectomized patient and who knows what a voice should sound like. By his efforts and those of Dr. Hanson, of East St. Louis, Ill., a device has been worked out which is the best I know of. It takes away the metallic sound which characterized the other instruments and allows for modulation of the voice as they do not. So I have asked the same woman who addressed this society last year to demonstrate the instrument to which she introduced me.

(The patient, Mrs. B., stated that her present apparatus [the artificial larynx of Roberts-Hanson] has produced an effortless modulated tone. She has found that whereas other types of artificial larynx make necessary a concerted action of the diaphragm, the use of this apparatus can be learned with greater ease. While she is particularly grateful for the previous instruments that have been produced, the apparatus which she now possesses is one that has made her happy.)

DR. THOMAS C. GALLOWAY: I think that the members of this society are fortunate to have Dr. Jackson demonstrate again that by a relatively simple procedure in properly selected cases the patient with laryngeal cancer has an 85 per cent chance of cure with a useful voice and a normal airway and a chance for a normal life with little risk to himself. I think that it is too bad that this information cannot be more widely disseminated, because in Chicago the feeling has become widespread that irradiation is the treatment of choice for such a carcinoma.

It is too bad this presentation could not reach the men who saw the advertising of a certain device for the application of radium in the larynx in a local medical publication. This device may have possibilities and has been useful in at least 1 case. But its advertising implies to the general practitioner that such a method offers a cure for cancer with no risk, no pain and no distress, though there is little evidence to support such implication.

I think that all the members of this society agree with all that Dr. Jackson has said, especially that in proper cases in which there is no fixation of the cord and in cases of early cancer in the anterior half of the vocal cord laryngofissure is the treatment of choice. I do not wish to deprecate the value of irradiation for many conditions, but I do not think that the impression should go abroad that at present anything can replace laryngofissure as the most satisfactory procedure in properly selected cases of early carcinoma.

DR. GEORGE E. SHAMBAUGH JR.: Little can be added to this complete and excellent demonstration. I think Dr. Jackson should receive particular credit for

introducing the dissection of the anterior commissure, which allows more patients to be cured by laryngofissure. I have used this procedure for 2 patients, 1 of whom has been presented. One item in technic was the use of a surgical diathermy cutting current in removing the cord after exposing the larynx except for the vocal process of the arytenoid, which has to be cut off by scissors. The removal was done entirely bloodlessly and quickly and easily.

DR. THEODORE WACHOWSKI: I should like to comment on what Dr. Galloway said in regard to so-called advertising. I would like to say that the Roentgen Society has recognized these facts and is trying to have that type of advertising eliminated. I think that if the sentiments of this society are made known the Chicago Medical Society will try to permit only ethical advertising in the *Bulletin*. I think that the things Dr. Galloway referred to should not be permitted and will not be.

DR. L. B. BERNHEIMER: If I understood correctly, Dr. Jackson said that with intrinsic, infiltrating lesions of the larynx the patient is given his choice between total laryngectomy and irradiation. I should like to know what Dr. Jackson's end results have been when radiotherapy was employed for this particular type of lesion. I ask this question because I am associated with an institution where a large number of laryngeal lesions are seen and where irradiation is used extensively, and it has been the experience of my associates and me that an infiltrating lesion resulting in cordal fixation never responds to irradiation. That is one type of lesion with which we do insist on surgical treatment, that is, laryngectomy. I cannot recall a single five year cure of an infiltrating laryngeal lesion treated by irradiation.

DR. L. Z. FISHMAN: I should like to ask Dr. Jackson in how many of the cases intrinsic carcinoma of the larynx was anaplastic and in how many it was of the slow-growing type.

DR. ADOLPH HARTUNG: The discussion did not deal with the relative value of irradiation and surgical intervention, and I have, therefore, little to add. Certainly results with irradiation have not been satisfactory so far as the ultimate outcome is concerned. I think that surgical intervention still has a place of choice except in special instances in the treatment of early lesions of the larynx.

DR. CHEVALIER L. JACKSON, Philadelphia: I appreciate the contributions of all those who joined in the discussion. Dr. Holinger asked about refrigeration. I have been asked about that before, but I cannot say anything about it, because, so far, my associates and I have not contributed any of the patients on whom Dr. Fay and Dr. Smith have made these experiments. I say "experiments," because patients are still being taken for that work on the basis of a clear understanding by the physician and the patient that refrigeration is purely experimental as yet and that nothing can be promised. So far we have not referred any patients from our service. However, Dr. Fay and Dr. Smith are continuing their studies and will report further on them.

I was much interested in Dr. Lederer's presentation and the excellent demonstration of the apparatus given by his patient. Certainly the mechanical larynx is an attractive field for continued and further work. It is the practice of my associates and me to give our patients postoperatively a systematic course of instruction first, to give them an opportunity to develop the buccoesophageal voice, which can be developed by many patients, more easily by men than by women. The work which in the United States was started by Morrison, of New York, is certainly productive of a better voice without apparatus than most patients will obtain without systematic instruction. On the other hand, when a preliminary period of training without apparatus has been given, the next thing is to get the patient in touch with one of the better forms of apparatus, and it is from the patients themselves that most of the important improvements in apparatus have come.

I thank Dr. Galloway for his emphasis on some of the points in connection with laryngofissure. Dr. Babcock, in his department, uses steel wire in all sorts

of cases, those in which the neck is operated on and other cases, and my associates and I took it over for buried sutures in the neck and have found it extremely satisfactory. The chief point in its favor is that experimental work has shown that its use is singularly free from irritating reaction in the tissues. When the sutures are superficial they may be felt under the skin and occasionally will be annoying and have to be removed, but if deep enough they cause no irritation whatever. We have been using them long enough to be well satisfied. On the other hand, I do not wish to lay any great stress on that point. Doubtless other materials are just as good, but we have used steel wire enough to feel that we want to continue with it. One point is that it is considerably stronger than silver. There are several different strengths, but in the size we use it almost never breaks.

I wish to congratulate Dr. Shambaugh on the excellent result in the patient whom those present saw this evening. I think the voice will still improve. My associates and I have found that the improvement continues for a number of years. I think that it is unwise to force the patients. The voice should be cultivated in quiet places and not forced in noisy ones. I think that this patient will get greater improvement, although the voice may be higher pitched than normal because of the shortness of the cords. The larynx is symmetric, with no granulomatous approximation, and I think that the voice will improve. One patient that we have, six or seven years after laryngofissure, asserts that every six months she can make a comparison with her friends and be assured that she is not wrong in her own conviction that her voice carries further and is still improving.

Dr. Wachowski's remarks do not call for a comment from me, as I am not familiar with the matters concerned. In regard to Dr. Bernheimer's point, which is important, my associates and I do not give the patient the choice. I said that in cases in which laryngofissure is not suitable for one reason or another we take the patient into consideration and go over the problem with him and his family but not in cases in which motility is impaired. I do not say that the conditions for which operation is not done are necessarily good ones for irradiation. However, if laryngectomy is not done, some treatment must be given. I have not the figures at hand as to what percentage were anaplastic. I know that it is a great minority.

## Book Reviews

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**Surgery of the Nose and Sinuses.** By Harry Neivert, M.D. First Chapter of Volume VIII of Nelson Loose-Leaf Surgery. Pp. 236, with 205 illustrations. New York: Thomas Nelson & Sons, 1939.

This chapter is a small volume in itself and is designed as the first chapter of a new section (volume 8) of the well known and deservedly popular Nelson Loose-Leaf Surgery series. The complete volume 8, shortly to be issued, will be entitled "Surgery of the Nose and Throat," with the remaining portion contributed by Dr. John D. Kernan, who is the author of the preface to the current chapter. Revision pages for the various volumes are issued to subscribers every six months, thus keeping the reader up to date in future developments of the subject.

The chapter entitled "Surgery of the Nose and Sinuses" is well done and the subject as thoroughly covered as it can be in the number of pages employed. Necessarily, extended discussions are eliminated, and the descriptions are brief, concise and well illustrated, as the 205 plates will attest. Anatomy, physiology and pathology are well covered, in sufficient detail to satisfy the average reader, and the authors cited are authoritative in their respective fields and subjects. Indeed, the author has quoted extensively from the writings of such well known teachers as Sluder, Skillern, Eggston, Jarvis, Coates, Faulkner, Metzenbaum, Samuel Cohen and Schaeffer.

Many illustrations have been borrowed from the works of these men, but they are carefully chosen and have definite application to the subject—none are superfluous. In addition, more than half of the cuts are original, especially those pertaining to the author's own particular methods and modifications of surgical procedures.

In his foreword, Dr. Kernan calls attention to the newer conceptions of the physiology of the nose and the newer philosophy deduced therefrom, namely, more conservative treatment and surgical intervention when possible and consequently less destruction of nasal function and therefore better general bodily health. He says, "In these articles dealing with the surgical procedures, medical conditions will be taken up only as their consideration is necessary to draw the line at which medical treatment should end and surgical therapy be adopted. The surgical procedures advocated, moreover, will, so far as possible, be those which preserve structure and restore function." This extract gives the key to the whole work. Etiology, symptomatology, diagnosis and treatment (other than surgical) are briefly summarized in order to leave more space for consideration of the surgical treatment, which is the purpose of the volume.

The author has arranged his material in good sequence for easy reference. The style is clear and the typography excellent. The book is readable, with added interest from personal observations and reminiscences but with a very minimum of case reports. The bibliography contains 81 references. The resident in otolaryngology and the graduate student will welcome the addition of this book to their libraries and will make frequent use of it. The younger rhinologist will find it a safe guide and a useful ready reference for the anatomy and pathology that he may be forgetting, and every rhinologist, irrespective of age, will enjoy and profit by its perusal.

**Treatment by Diet.** By Clifford J. Barborka, M.D., D.Sc., F.A.C.P., Associate in Medicine, Northwestern University Medical School, Chicago; Formerly Consulting Physician, The Mayo Clinic. Fourth edition, revised. Price, \$5. Pp. 691, illustrated. Philadelphia, London, Montreal: J. B. Lippincott Company, 1939.

This textbook, now in its fourth edition, brings down to date the many advances in the field of nutrition during the past two years. Some chapters had to be

completely rewritten; others, changed to conform to the newer concepts of the relation of diet to the diseased conditions under consideration.

The author has aimed to present a book that would crystallize the essentials of dietotherapy in order to enable the busy practitioner to use such practical methods as might, in given cases, aid him in his therapy. He has well succeeded in his purpose.

The book consists of 691 pages, is attractively bound and contains much information. The literary style and plan of the author will interest any reader because of the simplicity and thoroughness with which the subject matter is dealt with and discussed.

The material is divided into five parts. Part 1 deals with "Diet in Health" and covers the important points of adequate protein, mineral, acid-forming and base-forming foods, with a thorough consideration of the vitamin, water and energy requirements of man and similar data. It concludes with a discussion of the essential requirements of all diets and substitutions. Part 2 takes up the application of dietetic therapy, including the qualitative and quantitative factors and the method of calculating and applying them. Part 3 discusses "Diet in Disease" with practical methods for dietetic treatment of many diseased states. Part 4 concerns the routine hospital diets and special methods of feeding, including tube feeding and gastrojejunal feeding. Part 5 is the appendix and contains many useful charts of weights, average composition of food and many other valuable points. The bibliography is extensive and indicates to what great pains the author has gone in order to present a well balanced text. The index is complete.

Nutritional therapy is receiving greater recognition by otolaryngologists the world over, especially for certain types of sinusal infection, preoperative and post-operative states and laryngeal and esophageal obstructions.

The fine presentation of the subject by the author of this book should prove helpful in many instances and merits more careful examination and reflection by otolaryngologists. It is recommended to them and to bronchoesophagologists, as well as to those taking residencies in the fields in question.

**The Surgery of Injury and Plastic Repair.** By Samuel Fomon, Ph.D., M.D., formerly Major, Medical Corps, United States Army. Price, \$15. Pp. 1,400, with 2,000 illustrations grouped in 925 figures. Baltimore: Williams & Wilkins Company, 1939.

There has been a need for an up-to-date comprehensive textbook on the various surgical procedures available for handling injuries, malformations and new growths of the head and neck and their plastic repair. Such a book is of particular interest to the general practitioner, who sees the patients first and whose skill and care can do so much to prevent subsequent functional disability and deformity. The general surgeon, the otolaryngologist, the surgical ophthalmologist and the oral surgeon will find chapter after chapter of valuable specialized information on regions of the head and neck which is intelligently and lucidly written, satisfactorily illustrated and remarkable in its grasp of the complete literature pertaining to the development of the operative procedures for handling specific problems.

The book is divided into two main parts: The first part is devoted to the general principles of standard procedures and the newer concepts of transplantation of tissue, wounds, burns, shock, fluid, salt and acid-base balance, choice of anesthesia, the preoperative and the postoperative care of the patient. Totalling 518 pages, this portion consists of nine chapters, each of which contains numerous line drawings in black and white and in color and is complete, with an extensive bibliography.

The second part considers specific problems and their surgical management in the various parts of the head and neck. The regions have been grouped under fourteen chapter headings, including the cranium, the nose, the eyelid, the auricle, the maxillofacial region, the lip, the cleft lip and cleft palate, the mandible, the



salivary glands, surgical disorders of the skin, and casts and prostheses. The anatomy and physiologic functions are discussed. Operations are described in step by step detail when necessary and are often accompanied by similar step by step illustrations. This section contains 891 pages, including a good index. To otorhinolaryngologists the section devoted to the nose is of particular interest. It is 200 pages long and is noteworthy for its scope, clarity of presentation and excellence in illustration.

**Diseases of the Ear, Nose and Throat.** By Francis L. Lederer, M.D., F.A.C.S., Professor and Head of the Department of Laryngology, Rhinology and Otolaryngology, University of Illinois College of Medicine, Chicago; Chief of the Otolaryngological Service, Research and Educational Hospital. Second edition, revised. Price, \$10. Pp. 840, with 765 halftone and line engravings on 463 figures and 16 full page color plates. Philadelphia: F. A. Davis Company, 1939.

A second edition of the textbook by Dr. Lederer and his associates is just off the press. Its appearance, slightly less than a year since the first publication, proves the popularity of the first edition.

The work retains the general arrangement of the first edition: the division of the subject matter into five sections; the fine presentation of the material in a style that makes for easy reading; the treatment of details of anatomy, pathology, differential diagnosis, prognosis and treatment with such literary effectiveness as to compress an enormous amount of material into 840 pages; the arrangement of the page in two columns, and the diagrams, sketches, schemata, histologic studies and photomicrographs.

Some of the sections were corrected, and various changes were made in the chapters on anatomy in order to present certain features more clearly. Improvement was made in the illustrative material.

Here and there some changes were made according to suggestions from the author's associates.

The book is recommended for medical students, general practitioners, graduate students in otolaryngology, those taking residencies and otolaryngologists.

Dr. Lederer and his associates are to be congratulated on the production of a most attractive and useful book.

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## News and Comment

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### AMERICAN BOARD OF OTOLARYNGOLOGY EXAMINATION

The American Board of Otolaryngology will hold an examination at the Manhattan Eye, Ear and Throat Hospital, New York, June 3, 4 and 5, 1940.

# Directory of Otolaryngologic Societies \*

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## FOREIGN

### COLLEGIUM OTO-RHINO-LARYNGOLOGICUM AMICITIÆ SACRUM

President: Dr. Louis Ledoux, Brussels, Belgium.

Secretary: Prof. Dr. C. E. Benjamins, Verlengde Heereweg 143, Groningen, Netherlands.

### HUNGARIAN OTOLARYNGOLOGICAL SOCIETY

President: Dr. V. Zimányi, Zárda-u. 48, Budapest II.

Secretary: Dr. G. Kelemen, Reáltanoda-u., Budapest IV.

### SOCIEDAD RIOPLATENSE DE OTO-RHINO-LARINGOLOGÍA (ARGENTINE SECTION)

President: Dr. Raul Becco, B. Mitre 1690, Buenos Aires.

Secretary: Dr. Juan Manuel Tato, Santa Fé 1171, Buenos Aires.

### SOCIÉTÉ FRANÇAISE D'OTO-RHINO-LARYNGOLOGIE

Secretary: Dr. Henri Flurin, 19 Avenue Mac-Mahon, Paris, 17<sup>e</sup>.

## NATIONAL

### AMERICAN MEDICAL ASSOCIATION, SCIENTIFIC ASSEMBLY, SECTION ON LARYNGOLOGY, OTOTOLOGY AND RHINOLOGY

Chairman: Dr. A. W. Proetz, 3720 Washington Blvd., St. Louis.

Secretary: Dr. Leroy A. Schall, 270 Commonwealth Ave., Boston.

Place: New York. Time: June 10-14, 1940.

### AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Frank Brawley, 30 N. Michigan Ave., Chicago.

Executive Secretary: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.

Place: Cleveland. Time: Oct. 6-11, 1940.

### AMERICAN BRONCHOSCOPIC SOCIETY

President: Dr. John D. Kernan, 103 E. 78th St., New York.

Secretary: Dr. Lyman Richards, 319 Longwood Ave., Boston.

Place: New York. Time: June 5, 1940.

### AMERICAN LARYNGOLOGICAL ASSOCIATION

President: Dr. James A. Babbitt, 1912 Spruce St., Philadelphia.

Secretary: Dr. Charles J. Imperatori, 108 E. 38th St., New York.

Place: Westchester Country Club, Rye, N. Y. Time: May 27-29, 1940.

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\* Secretaries of societies are requested to furnish the information necessary to keep this list up to date.

AMERICAN LARYNGOLOGICAL, RHINOLOGICAL AND OTOLOGICAL SOCIETY, INC.

President: Dr. Lee M. Hurd, 39 E. 50th St., New York.

Secretary: Dr. C. Stewart Nash, 708 Medical Arts Bldg., Rochester, N. Y.

Place: Waldorf-Astoria Hotel, New York. Time: June 6-8, 1940.

*SECTIONS:*

Eastern.—Chairman: Dr. John R. Simpson, Medical Arts Bldg., Pittsburgh.

Southern.—Chairman: Dr. Walter J. Bristow, Doctors Bldg., Columbia, S. C.

Middle.—Chairman: Dr. Sam E. Roberts, Professional Bldg., Kansas City, Mo.

Western.—Chairman: Dr. Pierre Viole, 1930 Wilshire Blvd., Los Angeles.

AMERICAN OTOLOGICAL SOCIETY

President: Dr. Horace Newhart, 527 Medical Arts Bldg., Minneapolis.

Secretary: Dr. Thomas J. Harris, 104 E. 40th St., New York.

Place: Westchester Country Club, Rye, N. Y. Time: May 30-31, 1940.

## CHANGES IN THE INTERNAL EAR DUE TO INCREASED ENDOCRANIAL PRESSURE

THE HISTOLOGIC BASIS OF CONGESTIVE INNER EAR

JOSEPH FISCHER, M.D.

BOSTON

The question whether changes in the inner ear similar to choked disk in the eye occur as a result of increased endocranial pressure has not yet been definitely answered. This is shown by the confusion in nomenclature seen in such terms as choked labyrinth, neuritis of the eighth nerve, stagnation dropsy, neuritis labyrinthica and congestive inner ear.<sup>1</sup> Furthermore, many otologists deny absolutely that such changes take place.

Likewise the question of endocranial pressure itself is still in dispute. It is known to arise as a result of the disproportion between the size of the cranial cavity and its contents. A differentiation is made according to whether the pressure increases rapidly, as in acute processes, or gradually, as in chronic conditions. In this paper I shall deal only with chronic brain pressure. If one studies the enormous literature covering endocranial pressure, one finds that one can classify the various theories, according to the three main substances in the area, cerebrospinal fluid, blood and brain tissue, into three groups. One group explains the changes in pressure as caused by the cerebrospinal fluid; another attributes them to circulatory disturbances, while the third believes that direct compression of the brain substance is the cause.

How does chronic endocranial pressure affect the ear? Let me differentiate between the clinical symptomatology and the pathologic anatomy.

The earlier literature deals largely with the clinical side. Thus, for example, I<sup>2</sup> myself twenty years ago wrote an article entitled "Tumor

1. Moos, S.: Arch. f. Augen- u. Ohrenh. 4:179, 1874. Panse, R.: Arch. f. Ohrenh. 70:15, 1906. Cushing, H. W.: Tumors of the Nervus Acusticus and the Syndrome of the Cerebellopontile Angle, Philadelphia, W. B. Saunders Company, 1917. Beck, J., cited by Brunner, H.: Otologische Diagnostik der Hirntumoren, Berlin, Urban & Schwarzenberg, 1936, p. 3. Habermann, J.: Ztschr. f. Ohrenh. 75:19, 1917. Wittmaack, K.: Arch. f. Ohren-, Nasen- u. Kehlkopfh. 99:71, 1916.

2. Fischer, J.: Verhandl. d. Gesellsch. deutsch. Hals-, Nasen- u. Ohrenärzte 1:297, 1920; Monatschr. f. Ohrenh. 55:371 and 531, 1921.

of the Brain and the Ear," in which I reported a study of 130 cases of neoplasm of the brain observed in the surgical clinic of the University of Vienna. The clinical symptoms of congestive inner ear were described in that paper as follows: subjective noises in the head, tinnitus, diminished hearing, shortened bone conduction, lowered upper tone limit, dizziness, spontaneous nystagmus, abnormal irritability of the labyrinths, disproportion between objective labyrinthine reaction and subjective sensation of dizziness and, finally, marked changes in symptoms on repeated examinations. These symptoms of congestive inner ear were described as occurring in 77 per cent of cases of tumors of the brain in the anterior and the middle fossa, in comparison with choked disk in the eye, found in 90 per cent of the same cases.

Of much greater significance is the work dealing with the anatomic changes in the inner ear due to chronic brain pressure. A study of the literature, however, revealed the astounding fact, that, despite the importance of this subject, only a few positive findings are available. The reason for this is that the examinations were made on unsuitable material. Almost all the investigators described cases of tumor of the acoustic nerve or some other neoplasm of the posterior fossa; it was, therefore, impossible to decide whether the changes described in the inner ear were due to the chronic brain pressure (congestive inner ear) or the result of local damage.

In 1925 I<sup>3</sup> directed attention to this point, when I began the study of the histologic basis of congestive inner ear, on extensive autopsy material. In order to rule out local damage, I suggested strict requirements as follows: All cases of tumor of the acoustic nerve, cerebellar tumor or tumor of the pontile angle, in which the growth has encroached on the internal meatus so that it damaged the cochlear nerve directly were to be excluded. In the same manner must be excluded all cases of tumor of the posterior fossa in the vicinity of the petrous bone and all cases in which only the diseased petrous bone was microscopically examined. Naturally operative procedures, such as extirpation and decompression, may influence the histologic structure, because of hemorrhages and damage to the brain tissue.

Examining the literature with this point in view, I found only 1 case which fulfilled all the requirements. This was a case reported by Steinbrügge<sup>4</sup> in 1891. He investigated a tumor of the corpora quadrigemina with accompanying hydrocephalus, with which he found a depression of Reissner's membrane and bulging of the secondary tympanic membrane.

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3. Fischer, J.: Allgemeinerscheinungen im Bereiche des Cochlearapparatus, in Alexander, G., and Marburg, O.: *Handbuch der Neurologie des Ohres*, Berlin, Urban & Schwarzenberg, 1925, vol. 2, p. 1521.

4. Steinbrügge, H.: *Pathologische Anatomie des Gehörorganes*, in Orth, J.: *Lehrbuch der speciellen pathologischen Anatomie*, Berlin, A. Hirschwald, 1891, p. 119.

My material in 1925 was obtained at autopsy from 5 patients who had died of neoplasms of the brain in either the anterior or the middle fossa and who had had no surgical intervention. Complete bilateral serial sections (vertical to the petrous bone) were made.

Studies on these sections of the 10 petrous bones revealed numerous changes which were briefly summarized as follows:

1. Transudations and exudations (in the scala tympani and scala vestibuli, in the ductus cochlearis, in the aqueducts and also perineurally).
2. Hyperemia (especially venous, in the soft parts of the inner ear and of the petrous bone).
3. Hemorrhage (recent and old, in the membranous inner ear and in the labyrinthine capsule).
4. Changes in the walls of the blood vessels.
5. Local congestions (as in the nerve, the spiral ligament or the modiolus).
6. Cellular infiltrations.
7. Pigmentations.
8. Adhesions (in the membranous inner ear).
9. Formative changes of the membranous inner ear (ectasia, stenosis and collapse).
10. Atrophic and degenerative changes (in the sense organ and in the nerve ganglion apparatus).
11. Osseous changes (pressure atrophy).

For details and photomicrographs of the histologic changes the reader is referred to the original article.<sup>3</sup> The findings were confirmed by some but opposed by others.

G. Alexander,<sup>5</sup> in his address before the American College of Surgeons at Detroit in 1927, reviewed the findings and confirmed them, using the original photomicrographs.

S. J. Crowe<sup>6</sup> reported in 1929 on 2 neoplasms of the brain with changes in the inner ear. Although the histologic slides demonstrated the pathologic changes excellently, 1 patient had had chronic otitis media since childhood and did not have choked disks, and the other patient had a cerebellar tumor. Thus, local changes could not be excluded.

After that, attempts were made to solve the question of congestive inner ear experimentally. The first investigator (Marx<sup>7</sup>) found no

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5. Alexander, G.: Surg., Gynec. & Obst. **46**:361, 1928.

6. Crowe, S. J.: Anatomic Changes in the Labyrinth Secondary to Cerebellopontile and Brain Stem Tumors, Arch. Surg. **18**:982 (April) 1929.

7. Marx, H.: Ztschr. f. Hals-, Nasen- u. Ohrenh. **9**:135, 1924.

changes in the inner ear, but later experiments (Dunkel,<sup>8</sup> Tobeck<sup>9</sup>) were successful.

Dunkel<sup>8</sup> produced increased intracranial pressure in animals by the following procedures:

1. Forcible injections of Ringer's and Locke's solutions in the subdural spaces repeated over a long period.
2. Endocranial injections of paraffin.
3. Injections of paraffin into the aquaeductus Sylvii.
4. Injections of emulsion of lamp black into the subarachnoid spaces.

These experiments produced the same histopathologic changes of the inner ear as I found in man.

Tobeck<sup>9</sup> injected a large amount of paraffin and normacol<sup>9a</sup> in the regions of the internal auditory meatus. The animals given the injections lived from two days to twenty-one weeks. His findings were as follows: The changes in the inner ear were marked with acute endocranial pressure, but not so marked or absent with chronic pressure, the increased endocranial pressure being transmitted through the blood circulation. He denied any analogy between choked disk and congestive inner ear because of anatomic differences and because of the transmission of the pressure by means of the circulating system.

I find myself unable to agree with the conclusions drawn by Tobeck, for the following reasons:

(a) With sudden injections of such a large amount of paraffin local damage cannot be excluded.

(b) With injections in the region of the internal acoustic meatus local injuries may occur.

(c) The length of time that most of the animals lived after the injections was too short to establish chronic brain pressure.

In an article<sup>10</sup> written by me in 1935, entitled "Meningioma of the Posterior Fossa," the statement was made that the changes in the inner ear are due to local brain pressure accompanying such conditions as multiple hernias of the brain and vaginal dropsy of the ninth nerve (as described by Brunner<sup>11</sup> affecting the eighth nerve in a case of tumor of that nerve). The present study shows the same findings with neoplasms of the anterior and the middle fossa, so that the conclusion now drawn is that chronic brain pressure played a role in their production also.

8. Dunkel, G.: *Folia neuropath. eston.* 8:1, 1928.

9. Tobeck: *Beitr. z. Anat., Physiol., Path. u. Therap. d. Ohres* 30:341, 1933.

9a. Normacol is a proprietary preparation usually employed as a laxative. It is a plant mucus of the bassorin series, with the addition of *Rhamnus frangula*.

10. Fischer, J.: *Monatschr. f. Ohrenh.* 69:40, 1935.

11. Brunner, H.: (a) *Ztschr. f. d. ges. Neurol. u. Psychiat.* 132:57, 1931;  
(b) *Ztschr. f. Hals-, Nasen- u. Ohrenh.* 30:443, 1932.

In 1936 H. Brunner,<sup>12</sup> of Vienna, in his excellent book stated that the question of the congestive inner ear has not been as yet definitely decided and that further work is necessary to clear up the point. He also made histopathologic examinations. His conclusion was that only with acute changes of the brain pressure are there marked changes in the inner ear but that with chronic generalized brain pressure such changes are lacking. He refused to accept the analogy between choked disk and congestive inner ear, also because of anatomic considerations.

If one is not content with Brunner's conclusions and refers back to the histopathologic pictures described, one will see that many changes in the inner ear are present. Brunner merely differs in interpretation. The changes seen are explained by him as due to various causes, such as postmortem alterations, artefacts, inflammations, congenital hypoplasia, physiologic variations and senility. He attributed only two changes (hernia of the brain and edema of the ductus endolymphaticus) to generalized brain pressure. The justification of the analogy between choked disk and congestive inner ear will be discussed later in this paper.

In the most recent article on this subject, B. Hansson and C. O. Nylén<sup>13</sup> described 6 cases of tumor of the brain. They stated that only postmortem and no pathologic changes were observed in the inner ear. But in reviewing the description of their material one finds that they admit that most of the cochlea dropped out of the preparation, was destroyed by postmortem changes or suffered, in any case, because of unsatisfactory fixation, so that it is not clear how the authors could conclude that no pathologic changes were present.

Regarding the study of the membranous inner ear in general, this is a good opportunity to stress the need for ideal fixation of the petrous bone, if the histopathologic picture of the fine structure of the sense organ and the nerve ganglion apparatus is to be investigated. With such technic the literature would less often reveal reports stating that only postmortem and no pathologic changes are present. In any case, it is clear that the changes observed can be normal, postmortem or pathologic and that postmortem changes often destroy evidence of pathologic changes.

From the preceding references, it is clear that there has not as yet been a universal acceptance of the anatomic basis for congestive inner ear. Therefore, I felt that more microscopic study of clinical material was necessary. Accordingly I examined within the last few years specimens from hundreds of cases of neoplasms of the brain. From these I was able to select a new group of 5 in which the patient had died of tumor of the anterior and the middle fossa and had not had

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12. Brunner, H.: *Otologische Diagnostik der Hirntumoren*, Berlin, Urban & Schwarzenberg, 1936.

13. Hansson, B., and Nylén, C. O.: *Acta oto-laryng.* 23:370, 1936.



any surgical intervention. Thus serial sections of 10 petrous bones were obtained, which were stained and sectioned with the same technic as that used in the earlier series of 10 discussed in my 1925 article.

For clarity of presentation, excerpts of the hospital records will be given first, then the clinical otologic findings, the histologic description of the petrous bones and finally brief comment on each case. The cases are arranged according to the degree of change found, the specimens from the first case showing the early stage of congestive inner ear and those from each succeeding one showing more advanced changes than those from the preceding.

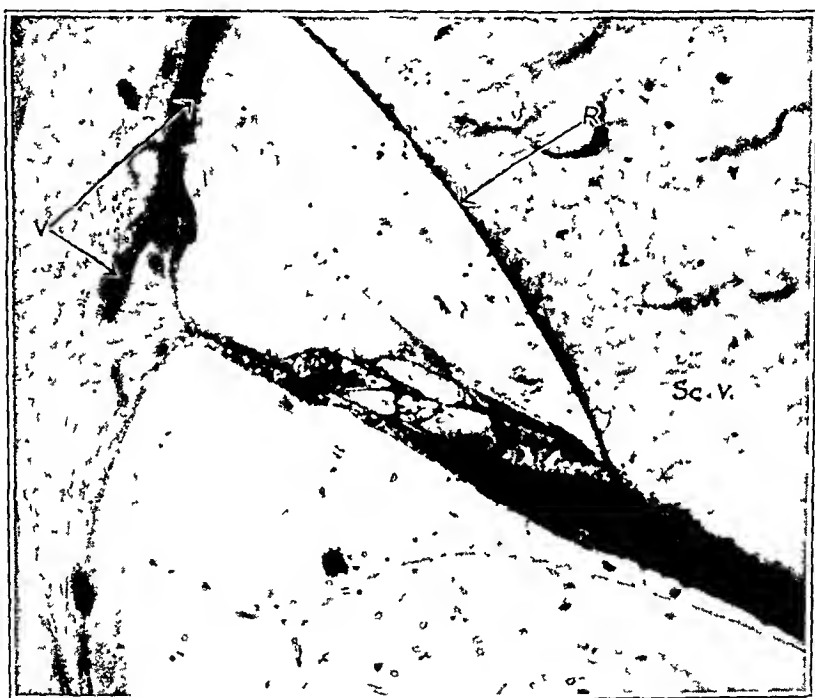


Fig. 1.—Photomicrograph from a case of frontal tumor; vertical section through the cochlea, showing the scala vestibuli (*Sc.v.*) and the ductus cochlearis filled with transudate (*t.*). Reissner's membrane (*R.*) is bulged outward. There are engorged vessels (*v.*) in the stria vascularis and in the ligamentum spirale, which is also edematously infiltrated. Although embedded in transudate the organ of Corti is intact.

#### REPORT OF CASES

**CASE 1.**—A 32 year old white man was admitted to the hospital with headache, weakness, anorexia, tinnitus (chirping and twittering), a sensation of fulness and seizures of jacksonian epilepsy. On examination the following signs were found: pain on percussion over the anterior part of right side of the cranium, left hemiplegia, paralysis of the left facial nerve, deviation of tongue to the left, a positive Babinski sign and choked disks.

Roentgen examination revealed deep impressiones digitatae in the frontal and parietal regions.

*Otologic Findings.*—Both drum membranes appeared normal. Perception of the accentuated whispered voice was 20/20 in each ear and that of the tuning forks C and c-4 normal, but the bone conduction was slightly shortened (ten seconds less than normal). Nystagmus was seen only in the end position. While the reaction to bilateral calorization was negative, that to unilateral calorization showed hyperirritability of each labyrinth. The falling and past pointing reactions were typically normal.

*Autopsy.*—The patient died six weeks after admission.

The autopsy was reported as revealing endothelioma of the right motor region.

*Histologic Observations on the Right Petrous Bone:* The labyrinthine capsule was markedly congested; the internal meatus was not enlarged. The cerebral ostium of the aquaeductus cochleae also showed signs of congestion in the form of

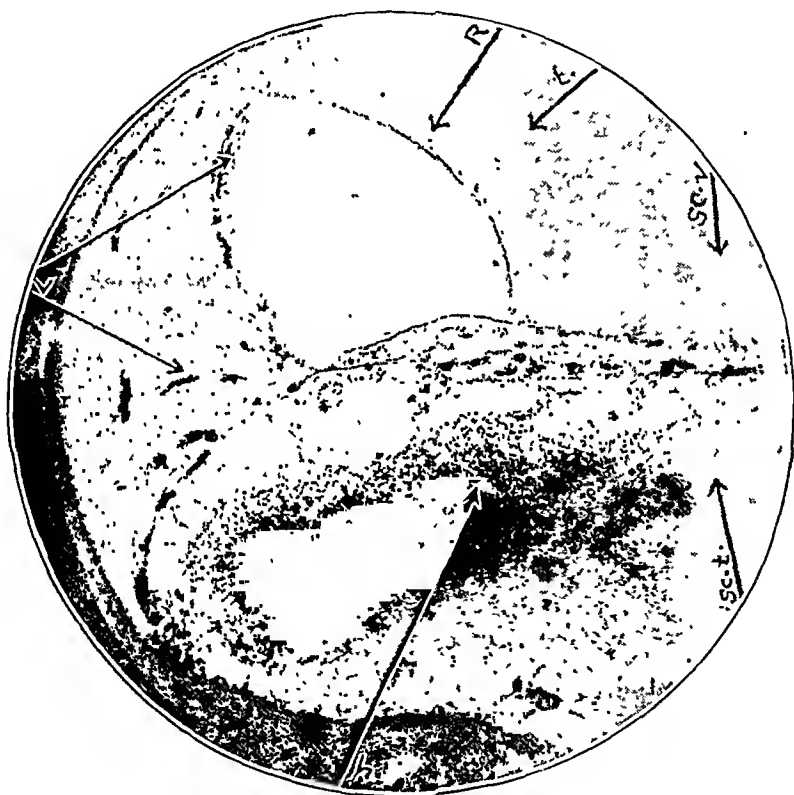


Fig. 2.—Photomicrograph from a case of frontal tumor; vertical section through the cochlea revealing the scala vestibuli (*Sc.v.*) filled with transudate (*t.*) and recent extensive hemorrhage (*h.*) in the scala tympani (*Sc.t.*). The marked bulging of Reissner's membrane (*R.*) has resulted in ectasia of the ductus cochlearis. Transudate (*t.*) surrounds the organ of Corti. Engorged vessels (*v.*) are seen in the stria vascularis and the spiral ligament.

subepithelial edema of the wall and transudation and recent hemorrhages in the lumen. The saccus endolymphaticus was occluded by subepithelial edema with resultant bulging of the endolymphatic duct above the occlusion, which was filled with homogeneous pinkish fluid.

*Membranous Inner Ear and Nerve Ganglion Apparatus:* A transudate was found in the scala of the cochlea and a slight amount in the ductus cochlearis of the basal turn. There was ectasia of Reissner's membrane and transudate in the tunnel space. The papilla basilaris, although embedded in the transudate, showed no changes. (The hair cells and supporting cells were intact [fig. 1]). The stria

vascularis contained engorged vessels; the vas spirale was prominent; the spiral ligament was edematous, and it also contained markedly engorged blood vessels. The spiral ganglion and the spiral nerve were normal. In the stem of the cochlear nerve was perineural and perivascular transudation, which extended into the internal meatus to the lamina cribrosa and partly into the tractus spiralis as far as the spiral ganglion. Recent hemorrhages were seen in the internal meatus. Transudate was present in the perilymphatic cistern of the vestibule and on the floor of the sacculus. There was ectasia of the ductus reuniens, with some transudate in its lumen. The other parts of the petrous bone were normal.

*Histologic Observations on the Left Petrous Bone:* The same changes were observed as in the right, only that the hemorrhages, especially in the scala tympani of the vestibular and the basal turn, were more extensive. Also, there was more marked bulging of Reissner's membrane, with ectasia of the ductus cochlearis and the ductus reuniens (fig. 2). The papilla basilaris was likewise intact, although embedded in the transudate.

*Comment.*—In this case the early stages of congestive inner ear were presented. The clinical symptoms, tinnitus, sensation of fullness and shortened bone conduction, with no changes in acuity of hearing, can all be explained by the histologic observations of perineural and perivascular transudation and the dropsy in the scalae. The organ of Corti, although embedded in homogeneous fluid, remained intact. It seems reasonable that if the patient had lived longer the increased endocranial pressure would have acted on and damaged the delicate cells of the organ of Corti and a more marked clinical picture would have resulted.

*CASE 2.*—A 41 year old white man entered the hospital with the following symptoms and signs: headache, nausea, vomiting, paresthesia, jacksonian epilepsy, episodes of sensorial aura, right hemiparesis and choked disks.

The roentgen examination showed deep impressiones digitatae suggestive of endocranial pressure.

*Otologic Findings.*—The otoscopic examination gave essentially normal results. The distance at which the accentuated whispered voice could be heard appeared somewhat diminished on both sides. Bone conduction was slightly shortened, the C fork being well heard, while perception of the c-4 fork was shortened, on the right ten seconds and on the left twelve seconds less than normal. There was spontaneous nystagmus of the first degree to both sides. The Romberg test gave negative results. The response to bilateral calorization was negative, while the unilateral test showed increased irritability of both labyrinths. Falling and pointing reactions were typically normal.

*Autopsy.*—The patient died two months after admission.

The autopsy was reported as revealing glioma of left parietal lobe, extending anteriorly into the gyrus centralis anterior.

*Histologic Observations on the Right Petrous Bone:* Pinkish homogeneous fluid was noted in most of the lymph spaces of the labyrinthine capsule. Close to the inferior surface of the pyramid was a large bone cell filled with transudate. On the posterior surface of the pyramid, beneath the internal meatus, the blood vessels were engorged. Congestion was marked within the modiolus and the septum

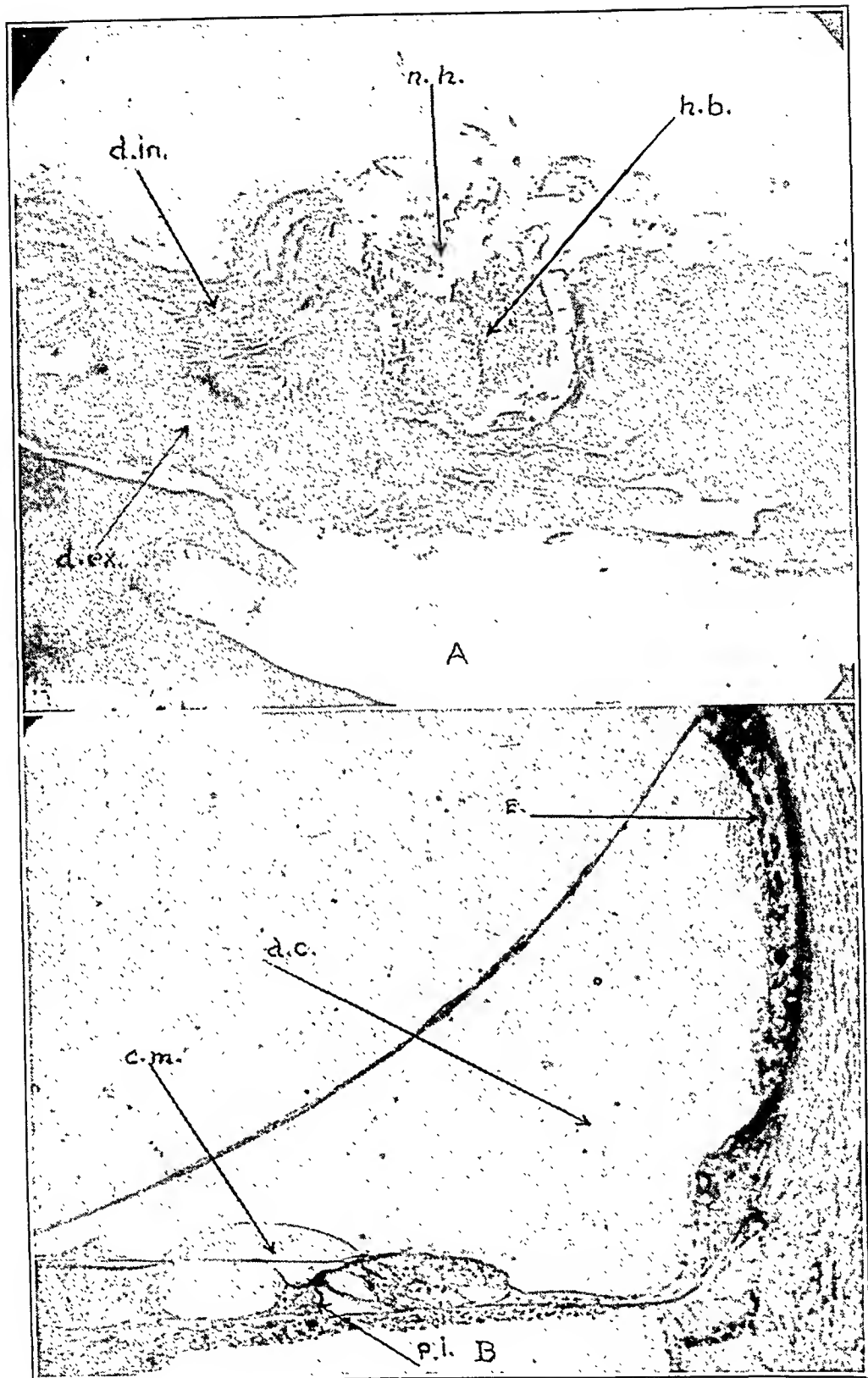


Fig. 3.—*A*, photomicrograph from a case of parietal tumor; hernia of the brain (*h.b.*) entering the dura of the middle fossa in the region of the tegmen tympani. The split dura, of which the outer layer (*d.ex.*) serves as periost and the inner layer (*d.in.*) shows a defect for the neck of the hernia (*n.h.*). *B*, photomicrograph from a case of parietal tumor; vertical section through the middle turn of the cochlea, showing moderate exudate (*E*) in the ductus cochlearis (*d.c.*), particularly on the stria vascularis and in the tunnel space. Beginning adhesions are seen between the inferior surface of Corti's membrane (*c.m.*) and the inner pillar of the papilla basilaris (*p.i.*).

scalarum. Most of the blood vessels revealed hyaline thrombosis and changes of their walls. On the anterior surface of the pyramid were multiple hernias of the brain. Above the tegmen tympani the dura was split into two layers: The outer, or inferior, layer was the periosteum covering the bone of the middle fossa; the inner, or superior, layer covered the brain and revealed an opening for the entrance of a hernia of the brain (neck of the hernia [fig. 3 A]). Under high power magnification distinctly pyramidal cells within the herniation could be seen. Between the meshy arachnoidea and the layers of the dura was a fissure-shaped space. Another hernia of the brain appeared, lateral to this herniation but much smaller and containing hemorrhages. This one was connected with two epithelial strands of cells. A third large hernia lay above the external meatus in the middle fossa.

**Membraneous Inner Ear and Nerve Ganglion Apparatus:** In the vestibular turn of the cochlea was seen an exudate poor in cells, which lay on the outer surface of Reissner's membrane (perilymphatic). Reissner's membrane was bulged out. On the papilla basilaris were noted changes of the hair cells, but the supporting cells were intact. The stria vascularis was rich in blood vessels and covered by a layer of exudate. The spiral ganglion contained engorged blood vessels; the interstitial tissue was edematous, but the ganglion cells were, for the greater part, intact. In the second turn of the cochlea was seen a small amount of exudate in the sulcus spiralis internus, in the angle of insertion of Reissner's membrane in the tunnel space and between Corti's membrane and the papilla basilaris. In the latter was a beginning adhesion (fig. 3 B). The ciliated cells were denuded but well seen; the supporting cells were normal; the spiral ganglion was intact. In the top turn of the cochlea the ciliated cells and the supporting cells were normal; the stria vascularis showed engorged blood vessels, and the vas spirale appeared prominent. In the perilymphatic duct, close to its tympanic ostium, exudation was found. The veins of the aquaeductus cochleae were congested. There was an accumulation of fluid and congestion of the vessels in the ductus reuniens and the sacculus. Exudate with few cells was noted in the utriculus, close to the beginning of the ductus endolymphaticus, as well as transudate in the saccus endolymphaticus.

**Histologic Observations on the Left Petrous Bone:** The same observations as in the right were noted, but the congestion was much more marked in the blood vessels of the modiolus, of the septum scalarum and of the labyrinthine capsule. In the lymph spaces of the cochlear capsule was an accumulation of pinkish homogeneous fluid. In the endolymphatic duct subepithelial edema could be seen. Within the tissue of the hernias of the brain marked hemorrhages appeared.

*Comment.*—In this case the clinical symptoms of congestive inner ear were more marked than in the previous case. Besides shortened bone conduction, diminution of the hearing for the upper tone limit and slight diminution for the accentuated whispered voice occurred.

The histologic basis for these clinical symptoms can be seen in the following observations:

First, in the vestibular and the basal turn of the cochlea were exudation with degeneration of sensory cells and edema of the interstitial tissue of the spiral ganglion.

Secondly, in the second turn of the cochlea, although only a small amount of exudate was seen, were beginning organization processes causing adhesions between Corti's membrane and the inner pillar of the organ of Corti with loss of cilia.

Thirdly, there were marked congestion of blood and lymph vessels and multiple hernias of the brain on both sides, due to the increased generalized brain pressure.

CASE 3.—A 35 year old white woman was admitted to the hospital presenting headache, nausea, vomiting, dizziness, disturbances of equilibrium, ataxic gait, paralysis of the left facial nerve, diminished corneal reflexes, weakened hand grasps and choked disks.

The roentgen findings revealed increased endocranial pressure.

*Otologic Findings.*—First Examination: Both drum membranes appeared normal. Perception of the accentuated whispered voice was 14/20 on the right side and 12/20 on the left. Bone conduction and perception of the c-4 fork were shortened on both sides. Spontaneous nystagmus appeared in the first degree to both sides. The reaction to perception of the bilateral calorization was negative, while the unilateral revealed hyperirritability of both labyrinths. There was no spontaneous past pointing, and the falling and pointing reactions were typically normal. Diadokokinesis was present, but there were no other disturbances of coordination. The otologic findings were overwhelmingly against tumor in the posterior fossa.

Examination Three Weeks Later: No changes in hearing appeared. Spontaneous nystagmus, horizontal with a slight rotary component, of the first degree to both sides was present. The reaction to bilateral calorization was negative. Falling and pointing reactions were typically normal.

*Autopsy.*—The patient died five weeks after admission.

Autopsy was reported as revealing glioma of the anterior part of the left cerebral hemisphere.

*Histologic Observations on the Right Petrous Bone:* The blood vessels over the posterior surface of the pyramid and in the petrosal angle were markedly congested. Similar congestion, with hyaline thrombosis of the vessels, was noted in the lymph spaces of the cochlear capsule. Circumscribed enlargement of the internal auditory meatus was due to erosion of the bony wall caused by the ingrowth of pacchionian granulations. Figure 4*A* shows distinctly the arachnoid sheath piercing the dura and eroding the bony wall in the form of pacchionian granulations. There is seen also, lying between the split dura mater, a large hernia of the brain, which is divided into four compartments by septums of connective tissue (fig. 4*B*). Under higher power magnification brain tissue with pyramidal cells was recognized. Endothelial strands were found in the dura, which was devoid of blood vessels. There were subepithelial edema in the aquaeductus cochleae and loose areolar tissue in the perilymphatic duct. The cerebral ostium of the aquaeductus cochleae was funnel shaped in its bony portion. While the dura covered the bony canal as periostium, the arachnoid, instead of coating the glossopharyngeal nerve as a thin layer, here formed meshes or loose convolutions within the lumen. These arachnoid convolutions were edematous and showed finger-like projections (two long and three short) into the dura, as pacchionian granulations. Where the larger granulations occurred, erosions of bone were seen, an observation substantiated by the presence of osteoclasts and Howship's lacunas. Within one loop of the arachnoid convolutions were amyloid bodies.

*Membranous Inner Ear and Nerve Ganglion Apparatus:* The slide revealed stenosis of the ductus cochlearis in the vestibular turn of the cochlea due to adhesions between Reissner's membrane, Corti's membrane and the stria vascularis, resulting from organized exudates (fig. 5*A*). On the papilla basilaris the cilia were absent and the ciliated cells degenerated, but the supporting cells were intact.

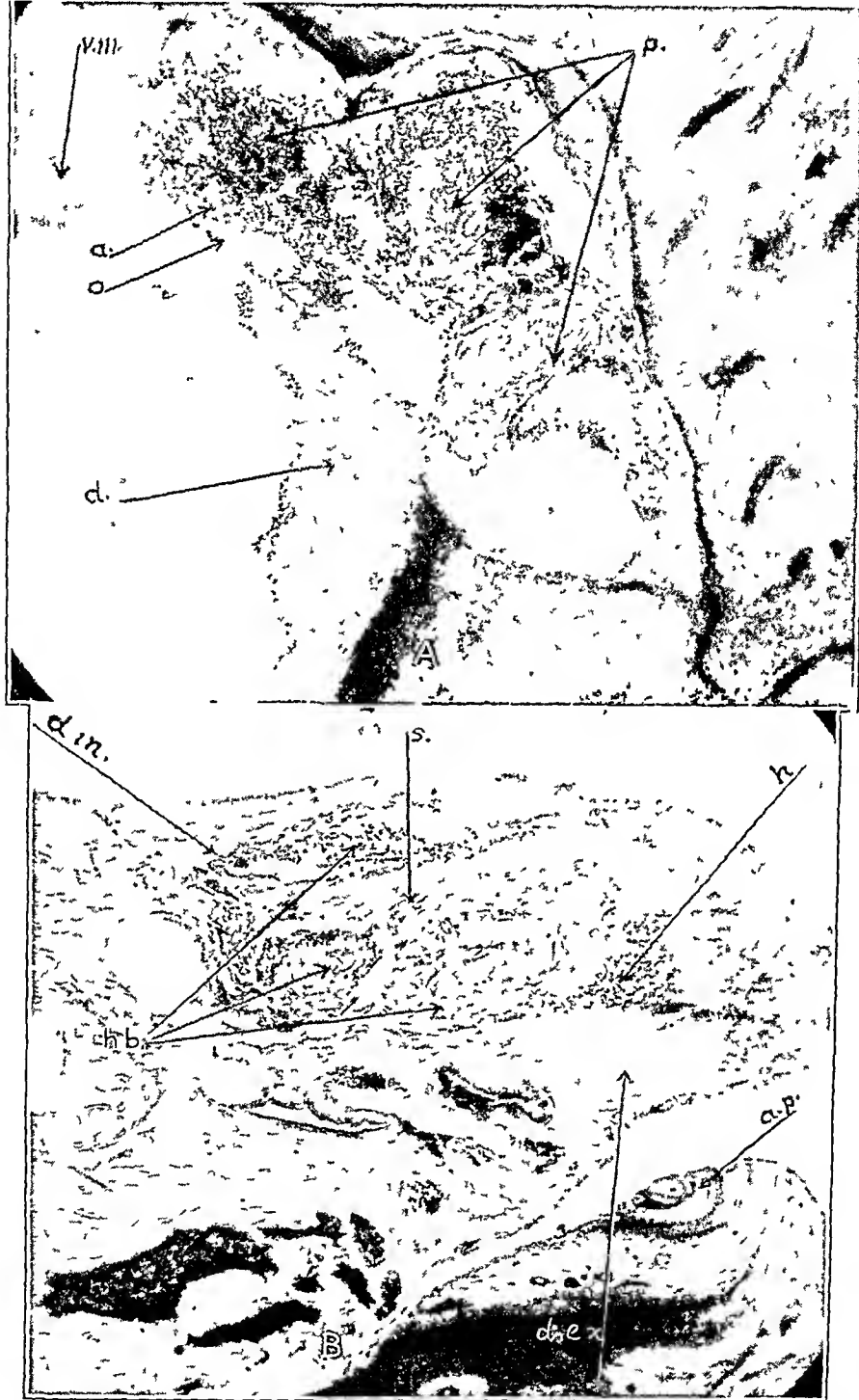


Fig. 4.—*A*, photomicrograph from a case of frontal tumor; section through the internal meatus, showing marked thickening of the dura (*d.*), which is pierced at (*o*) by the arachnoid sheath (*a.*) of the cochlear nerve (*VIII*). Pacchionian granulations (*p.*) are seen invading the bony walls of the canal. *B*, photomicrograph from a case of frontal tumor; hernia of the brain (under high power) above the anterior surface of the pyramid (*a.p.*). The dura is split into internal (*d.in.*) and external (*d.ex.*) layers, with septums of connective tissue (*s.*) separating a hernia of the brain (*h.b.*). Within the divisions pyramidal cells can be recognized. Recent hemorrhages are seen at (*h.*).

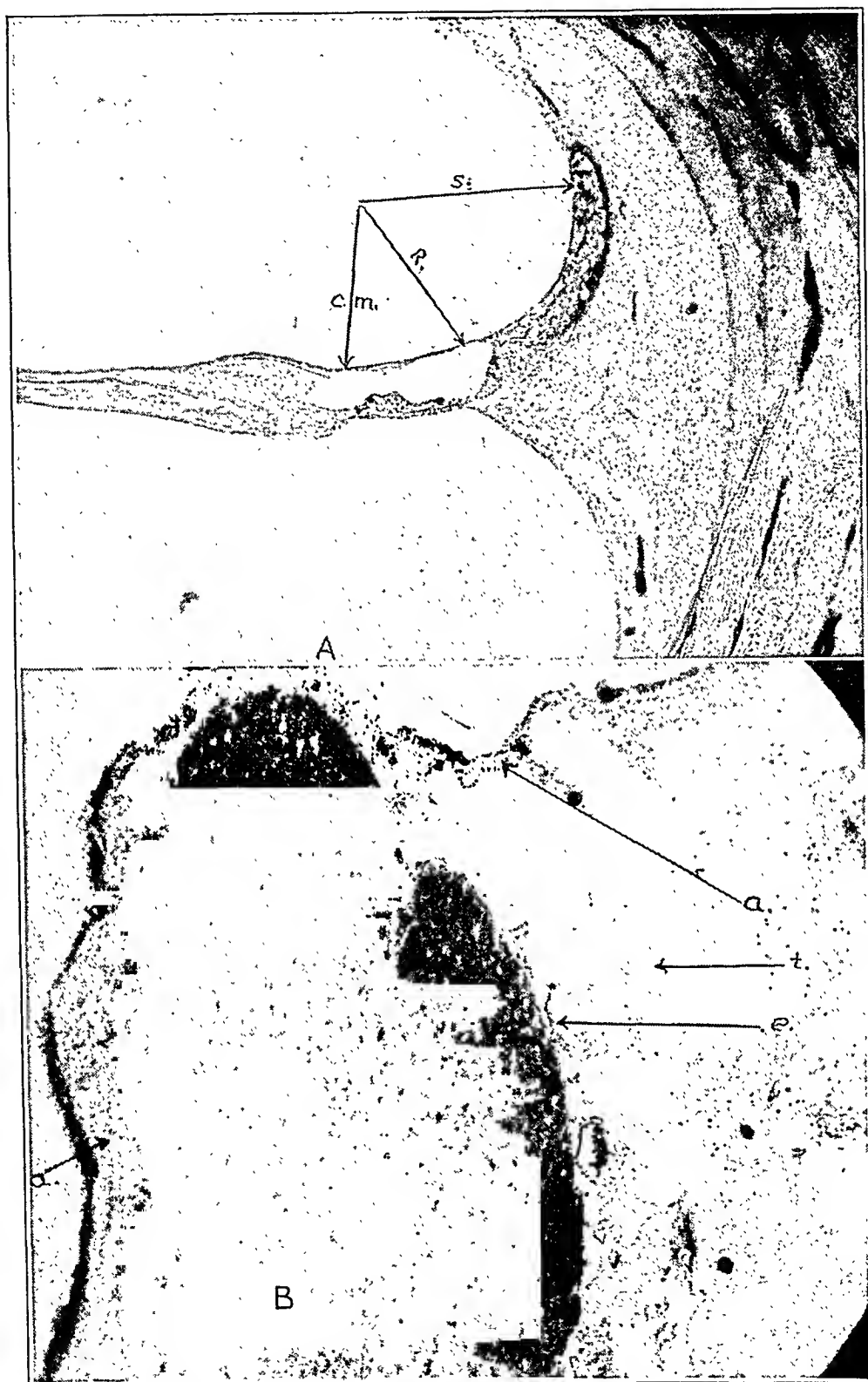


Fig. 5.—*A*, photomicrograph from a case of frontal tumor; vertical section through the vestibular turn of the cochlea, showing complete adhesion between Reissner's membrane (*R.*) and the stria vascularis (*s.*), as well as Corti's membrane (*c.m.*), with resulting stenosis of the ductus cochlearis. The sensory cells of the organ of Corti show degeneration. *B*, photomicrograph from a case of frontal tumor; vaginal dropsy of the cochlear nerve in the internal meatus. A large space filled with transudate (*t.*) lies between the epineurium (*e.*) of the eighth nerve and the infiltrated and markedly lifted arachnoid sheath (*a.*).



There was edema of the interstitial tissue, and the spiral ganglion cells were somewhat degenerated. The stria vascularis was adherent to Reissner's membrane from the upper angle of insertion to the vas prominens. Edema of the ligamentum spirale was present. The cochlear nerve within the internal meatus showed extensive vaginal dropsy. This is seen if one examines figure 5*B*, in which one can easily note a large space between the markedly lifted arachnoid and the epineurial sheath of the cochlear nerve. This space was filled with a homogeneous pinkish fluid. The arachnoid itself showed edematous infiltration. Circumscribed transudation in the perilymphatic spaces around the sacculus could be seen.

**Histologic Observations on the Left Petrous Bone:** The same findings were noted as in the right, but in addition to vaginal dropsy of the cochlear nerve a similar condition (vaginal dropsy) of the facial nerve was seen (fig. 6). In



Fig. 6.—Photomicrograph from a case of frontal tumor; section through the internal meatus with the crista horizontalis (*c.h.*) separating the sheath of the cochlear nerve below from the facial nerve above. The arachnoid sheaths (*a.VII*, *a.VIII*) are infiltrated with transudate. Between the thickened dura (*d.*) and the lifted arachnoid of the cochlear nerve recent hemorrhages (*h.*) are seen in the subdural space.

the internal meatus recent hemorrhages were seen in the subdural space (between the lifted arachnoid and the thickened dura), and there was a pinkish transudate in the lymph spaces of the vestibule, as well as an edematous infiltration in the connective tissue of the subarcuate fossa. The saccus endolymphaticus was closed by a subepithelial edema, with an enlargement above the lumen (fig. 7). Disseminated hernias of the brain were noted along the middle fossa.

**Comment.**—From a clinical point of view this case is interesting. Many symptoms (such as headache, dizziness, disturbance of equi-

librium and ataxic gait) pointed to a neoplasm of the posterior fossa. The otologic findings were helpful in localizing the lesion of the brain. The negative reaction to bilateral calorization, the typical past pointing and falling reaction and the absence of disturbances of coordination ruled out the likelihood of a neoplasm of the posterior fossa. As far as the pathologic picture of the congestive inner ear is concerned, multiple hernias of the brain were seen along the middle fossa, causing in certain areas pressure atrophy of the bone. There was also vaginal dropsy of the cochlear, facial and glossopharyngeal nerves. The enlargement of

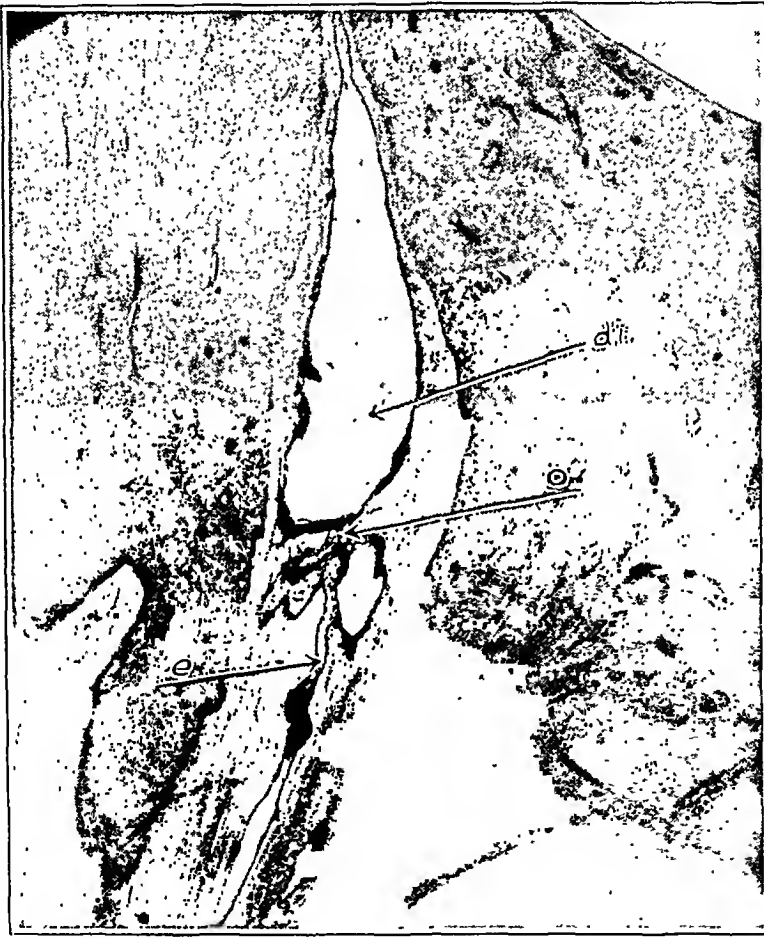


Fig. 7.—Photomicrograph from a case of frontal tumor; section through the saccus and the ductus endolymphaticus. Extreme subepithelial edema (*e.*) in the saccus causes complete occlusion (*o*) of lumen, with resulting distension (*di.*) above.

the aquaeductus cochleae is due to the pressure exerted by the pachionian granulations. In the membranous inner ear there are beginning organizations, with adhesions and, as a sequela, degenerative changes in the delicate structure of the sense organ.

CASE 4.—A 48 year old white woman entered the hospital presenting headache, malaise, anorexia, dizziness, tinnitus, diminution of the sense of touch and pain on the left side, impairment of the sense of position and movement, astereognosis, hemianopia and choked disks.

*Otologic Findings.*—The drum membranes appeared normal. Perception of the accentuated whispered voice was 8/20 on the right side and 10/20 on the left. Bone conduction was shortened on both sides. No spontaneous nystagmus was seen, and bilateral calorization yielded negative results, while unilateral calorization showed irritability of both labyrinths. Falling and pointing reactions were typically normal.

*Autopsy.*—The patient died seven weeks after admission.

Autopsy was reported as revealing glioma of the right parietal lobe invading the deeper structures and extending back into the occipital lobe.

*Histologic Observations on the Right Petrous Bone:* On the right side were seen engorged blood vessels invading the underlying bones of the pyramid. The



Fig. 8.—Photomicrograph from a case of parietal tumor; section through the aqueductus cochleae, showing its cerebral ostium (c.o.), with ampullar enlargement of the canal. The invading meninges are accompanying the ninth nerve. Meshes and loops are formed by the arachnoid, and two pacchionian granulations (p.) are invading the bony wall.

internal meatus showed periosteal thickening. Hemorrhages of the subdural space in the internal meatus and the facial canal were present. The cerebral ostium of the aqueductus cochleae showed funnel-shaped enlargement. The meninges were evaginated from the posterior fossa into the canal. The dura lined the bony wall; the meshy arachnoid was lifted away from the glossopharyngeal nerve, and between the external sheath of the arachnoid and the epineurium of the nerve

was a space filled with transudate and blood (vaginal dropsy). One could see also two projections, pacchionian granulations, originating from the arachnoid, invading the dura and entering the bony canal (fig. 8). On the tympanic ostium of the aquaeductus cochleae septums of connective tissue were found.

Membranous Inner Ear and Nerve Ganglion Apparatus: Pigmentations in the modiolus and the ductus reuniens were apparent. An increase of perilymphatic tissue in the pars superior of the inner ear was seen. There were adhesions between the sacculus and the medial wall of the vestibule. The ductus endolymphaticus was occluded by connective tissue. Degeneration of the organ of Corti and the nerve ganglion apparatus was evident. The spiral ganglion of the vestibular portion of the cochlea was almost entirely replaced by connective tissue,

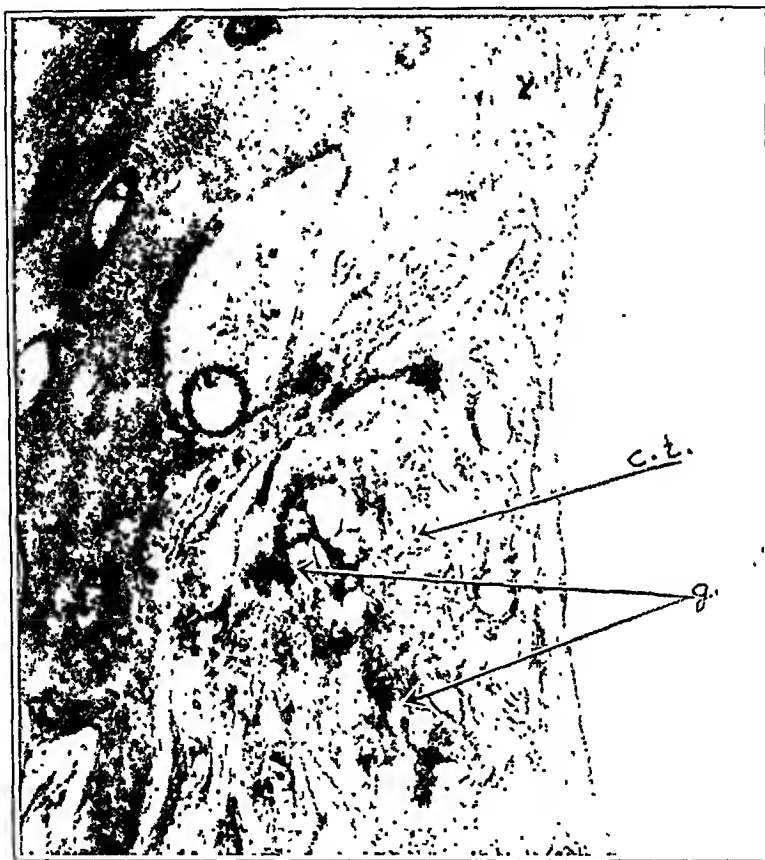


Fig. 9.—Photomicrograph from a case of parietal tumor; section through the spiral ganglion of the vestibular portion of the cochlea, showing degeneration of the majority of ganglion cells (*g.*), with hyperplasia of the interstitial connective tissue (*c.t.*).

so that only a few degenerated ganglion cells were recognized (fig. 9). The spiral ganglion of the middle turn showed only swelling of the interstitial tissue. In the highest turn, the spiral ganglion showed slight changes. Atrophy of the stria vascularis and the vas spirale of the vestibular and the basal turn was present.

Histologic Observations on the Left Petrous Bone: The observations were similar to those on the right side, but there were hemorrhages within the dural layer as well as in the subdural space. The dura of the middle fossa was markedly thickened and contained many endothelial strands and disseminated small hernias of the brain. In various regions of the blood vessel changes of the wall were seen

(atrophy of the media and calcification and hyperplasia of the intima). The cochlear nerve showed disseminated circumscribed degenerations. In the spiral ganglion there was interstitial hyperplasia.

*Comment.*—In this case advanced changes of congestive inner ear were noted. As a sequel of increased general brain pressure, existing over a long period, secondary processes had occurred, such as alterations in the blood vessels, thickening of the dura of the middle and the posterior fossa with pressure atrophy of the underlying bone and, finally, degeneration of the sense organ and the nerve ganglion apparatus. The latter changes start in the basis of the cochlea (the vestibular and

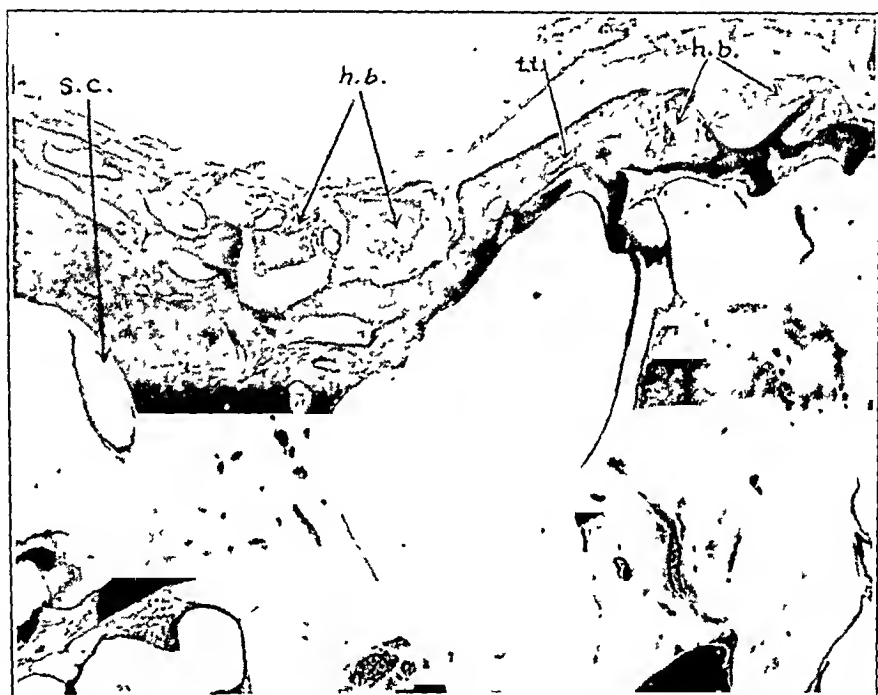


Fig. 10.—Photomicrograph from a case of occipital tumor; vertical section through the middle and inner ear, showing multiple hernias of the brain (*h.b.*) in the middle fossa above the tegmen tympani (*t.t.*) and the semicircular canals (*s.c.*).

the basal portion contain the highest degree of atrophy) and extend to the top in decreasing degrees.

**CASE 5.**—A 45 year old white man entered the hospital with the following symptoms and signs: occipital headache, weakness, dizziness, spots before the eyes, tenderness to percussion over the right side of the occiput, right hemianopia and bilateral choked disks.

The roentgen findings revealed increased endocranial pressure.

*Otologic Findings.*—The drum membranes appeared normal. Perception of the accentuated whispered voice was 5/20 on both sides. Bone conduction was

shortened, and perception of the upper tones (c-4) was markedly diminished on both sides. There was no spontaneous nystagmus. Calorization showed labyrinthine irritability on both sides. The falling and pointing reactions were typically normal.



Fig. 11.—*A*, photomicrograph from a case of occipital tumor; section through the petrous bones, showing a large hernia of the brain piercing the dura (*d.*) of the middle fossa. The neck of the hernia is seen at *n.h.* Meshy arachnoid (*a.*) surrounds the hernia, and marked pressure atrophy of the bone is seen. *B*, photomicrograph from a case of occipital tumor; axial section through the cochlea. The tremendous enlargement of the internal auditory meatus may be compared with the size of the cochlear nerve.

*Autopsy.*—The patient died five weeks after admission.

Autopsy was reported as revealing a large neoplasm of the right side of the occipital lobe.

**Histologic Observations on the Right Petrous Bone:** There were extravasation of blood and marked congestion of the blood vessels in the modiolus, the septum scalarum and the medullary spaces of the pyramid. Old hemorrhages in the internal meatus, the facial and the carotid canal were present. Pacchionian granulations invading the internal meatus, causing erosions of the bony wall, could be seen. Multiple hernias of the brain appeared on the anterior surface of the pyramid (above the semicircular canals, above the tegmen tympani and above the roof of the external meatus [fig. 10]).

**Membranous Inner Ear and Nerve Ganglion Apparatus:** Thready exudates were found in the scala tympani of the vestibular turn. Old hemorrhages and connective tissue were seen in the ductus perilymphaticus, near its tympanal ostium. A large amount of pigment was noticed in the modiolus. The saccus endolymphaticus contained blood pigment and connective tissue. The spiral ganglion of the vestibular and the basal turn was partially replaced by connective tissue. There was degeneration of the sense cells in the vestibular and the basal portion, with secondary atrophy of the stria vascularis and the vas spirale.

**Histologic Observations on the Left Petrous Bone:** Similar observations were noted, with the following additions: Old hemorrhages were seen in the hiatus spurius of the facial canal. A large hernia of the brain appeared above the frontal semicircular canal, showing the invasion of the brain tissue into the underlying bone. The destruction of bone is seen in figure 11 *A* as a butterfly-shaped defect. The internal auditory meatus was markedly enlarged (fig. 11 *B*). The bony destructions were caused by osteoclasts and Volkmann's perforating canals. Thready exudate was found also in the middle turn of the cochlea.

*Comment.*—In this case the later stages of congestive inner ear were seen. The main changes were as follows: degenerative atrophy of the sense organ and the nerve ganglion apparatus, with atrophy of the stria vascularis and the vas spirale. Also, because of the increased generalized brain pressure there were multiple hernias of the brain (above the semicircular canals, the roof of the middle ear and the eustachian tube) and pressure atrophy of the petrous bone (the middle fossa and the internal meatus).

#### CONCLUSIONS FROM THE MICROSCOPIC STUDIES

Examination of the recent serial sections of 10 petrous bones, as well as of the earlier set of 10, results in the conclusion that numerous changes in the inner ear (congestive inner ear) are caused by chronic increased brain pressure. These changes can be classified into the following six main groups:

I. Transudation, exudation and lymphatic congestion (dropsy and edematous infiltration) within the membranous inner ear and the nerve ganglion apparatus (vaginal dropsy of the seventh, eighth and ninth nerves).

II. Hyperemia (especially venous), hemorrhages and alterations of the walls of the blood vessels within the inner ear and the petrous bone.

III. Formative changes within the membranous inner ear (ectasia, stenosis and collapse) in the ductus cochlearis, the ductus endolymphaticus, the ductus perilymphaticus and the ductus reuniens.

IV. Formations of hernias of the brain and pacchionian granulations.

V. Secondary (later) changes: pigmentations, attachments and adhesions in the membranous inner ear and ascending atrophy of the nerve ganglion apparatus.

VI. Pressure atrophy of the bone due to osteoclasts and Volkmann's perforating canals, caused by herniations of the brain and pacchionian granulations.

A more detailed discussion of these groups may be desirable.

*Group I (Transudation, Exudation, Etc.).*—The amount and extent of the fluid vary from small circumscribed perineural and perivascular accumulations within the internal meatus to extensive dropsy within the perilymphatic and endolymphatic spaces of the pars inferior and the pars superior of the inner ear. Furthermore, edematous infiltration of the tissues is seen, as in the ligamentum spirale or the ganglion spirale, or in the form of subepithelial edema of the lumen of the aquaeductus cochleae.

It is of interest to note the vaginal dropsy of the cochlear, facial and glossopharyngeal nerves, as in cases 1, 3 and 4. The arachnoid is edematously infiltrated, lifted away from the epineural sheath; the space between the two (epineural sheath and arachnoid) is filled with a large amount of transudate (fig. 5 B).

*Group II (Hyperemia, Hemorrhages and Vascular Changes).*—The hyperemia is due mostly to passive venous congestion and occurs within the membranous and bony inner ear. It is particularly marked in the vena aquaeductus vestibuli, the vena aquaeductus cochleae and their tributaries. Engorged blood vessels are seen in the axis of the cochlea (vena spiralis modioli), in the endosteal portion of the scala tympani and in the septum scalarum. The same hyperemia is seen also on the floor and the roof of the vestibule. The vessels of the stria vascularis are markedly dilated and engorged, bulging into the lumen of the ductus cochlearis.

Hemorrhages are seen in all degrees and stages, from a small circumscribed extravasation to a massive hemorrhage, as in figure 2, and from recent to old hemorrhages. There are also hemorrhages found within the pacchionian granulations and within the hernias of the brain as in figure 4 B.

The walls of the blood vessels are edematously infiltrated, swollen, thickened or homogeneous. In cases in which endocranial pressure has been increased over a long period the arteries show hyperplasia of the intima and pressure atrophy of the media, particularly in the regions where these arteries run along the underlying bone.



*Group III (Formative Changes Within the Membranous Inner Ear).*—In this group belong such changes as ectasia, stenosis and collapse of the ductus cochlearis.

In case 1 marked ectasia was indicated by the bulging of Reissner's membrane due to the large amount of transudate within the scalae (figs. 1 and 2). A similar condition was found within the ductus reuniens and the ductus endolymphaticus. In figure 7 complete occlusion of the saccus endolymphaticus due to subepithelial edema of its wall can be distinctly seen, causing funnel-shaped ectasia of the lumen above the occlusion.

In contrast to the enlargement of the lumen (ectasia) one finds, on the other hand, narrowing (stenosis) or complete absence (collapse). These changes are brought about by organization of the exudate with resultant adhesions.

Figure 5 *A* gives an example of stenosis of the cochlear duct due to adhesion of Reissner's membrane to Corti's membrane and the stria vascularis.

*Group IV (Hernias of the Brain).*—The hernias of the brain were found on the anterior surface of the pyramid in the middle fossa (above the semicircular canals, above the canal for the facial and the superficial petrosal nerves and above the roof of the tympanic cavity and the eustachian tube).

The presence of hernias of the brain was known by older authors, such as Cruveilhier.

In 1872 von Recklinghausen<sup>14</sup> observed that in cases of increased endocranial pressure in which an autopsy was performed the removal of the brain was attended with some difficulty, due to adhesions between the temporal lobe and the dura of the middle fossa. After the removal of the brain he found many small disseminated pediculated pieces of brain tissue which remained attached to the dura (hernias of the brain).

Microscopic investigations of hernias of the brain were made by many pathologists.<sup>15</sup>

Benecke<sup>15a</sup> described the development of the hernias on the basis of increased endocranial pressure causing the rupture of the pia with prolapse of the brain tissue into pacchionian granulations.

14. von Recklinghausen, F. D.: Verhandl. d. phys.-med. Gesellsch. in Würzburg 5:9, 1872.

15. (a) Benecke, J.: Virchows Arch. f. path. Anat. 119:60, 1890. (b) Blasius, N.: ibid. 165:504, 1901. (c) Wojno, O.: Frankfurt. Ztschr. f. Path. 9:279, 1912. (d) Prym, P.: Deutsche med. Wchnschr. 49:1145, 1923. (e) Franz, I.: Frankfurt. Ztschr. f. Path. 33:72, 1926. (f) Erdheim, J.: Jahrb. f. Psychiat. u. Neurol. 39:322, 1919. (g) Mayer, O.: Ztschr. f. Ohrenh. 75:95, 1917. (h) Brunner.<sup>11a</sup> (i) Mehler, L., and Satz, L.: Ztschr. f. d. ges. Neurol. u. Psychiat. 151:441, 1934.

Erdheim<sup>15f</sup> stated that hernias of the brain are caused by increased endocranial pressure which forces the brain tissue as globule-shaped masses into the pacchionian granulations. In the first stage the hernias do not occupy the granulations entirely, but as the pressure increases the pacchionian granulations become filled entirely, and the arachnoid sheath becomes adherent to the dura.

The hernias of the brain are not found throughout but are localized only where there has been previous development of pacchionian granulations.

*Group V (Secondary [Later] Changes).*—Scattered pigmentations were found in the scalae, the modiolus, the ductus reuniens, the perilymphatic duct and the floor of the vestibulum.

Adhesions resulting from organization processes were seen. In figure 3 *B* there are adhesions between the inferior surface of Corti's membrane and the inner pillar of the organ of Corti. Other adhesions are seen in figure 5 *A*, between the stria vascularis and Reissner's membrane, extending from the upper angle of insertion to the vas prominens.

The secondary atrophic changes in the sense organ and the nerve ganglion apparatus show extending degeneration. This is particularly shown in cases 4 and 5, in which one sees the most severe degenerative changes in the vestibular and basal turn of the cochlea, less involvement in the middle turn and least involvement or no changes of the cell structure in the top turn. The earliest degenerative changes in the organ of Corti are seen as a loss of the cilia; further degenerations occur with destruction or loss of the ciliated cells but no involvement of the supporting structure. The most severe conditions, then, are atrophy of the stria vascularis and the vas spirale. Within the spiral ganglion there is in the earlier stages only a swelling of the ganglion cells; later degenerative changes are shown as destruction of the cells with increase of the interstitial tissue (fig. 9), and in the most severe form of degenerations almost complete loss of the ganglion cells is noted, with replacement by connective tissue. In the nerve there are various stages of degeneration, extending from involvement of the myelin sheath to replacement by connective tissue.

*Group VI (Pressure Atrophy of the Bone).*—The bony changes are destructive processes due to increased brain pressure. The bone becomes destroyed by osteoclasts and Volkmann's perforating canals. Circumscribed bony erosions are seen in the regions where pacchionian granulations and hernias of the brain invade the underlying bone (figs. 4 *A* and *B*, 8, 10 and 11 *A*). With generalized brain pressure extending over a long period, diffuse pressure atrophy of the bone is seen. In figure 8 one can notice a funnel-shaped enlargement of the bone of the aquaeductus cochleae near its cerebral ostium, and in figure 11 *B* there is marked enlargement of the entire internal auditory canal.

## ANALOGY BETWEEN AURAL CHANGES AND CHOKED DISK

After the histopathologic observations have been described and discussed the question arises whether it is justifiable to designate these changes "congestive inner ear." In other words, can it be stated that there is an analogy between the observations with choked disk and those in the cases described? In order to answer this question one must review the anatomic relation of *the eye* to the cranial cavity (choked disk) and, on the other hand, the relation of *the ear* to the cranial cavity (congestive inner ear).

*Anatomic Relation of the Eye to the Cranial Cavity (Choked Disk).*  
—All the theories as to the development of choked disk can be condensed and classified into the following three conceptions:

1. The mechanical theory.
2. The inflammatory theory.
3. The neurotrophic theory.

Most authors believe in the mechanical theory, but they give different explanations of the manner in which the pressure acts.

Von Graefe<sup>16</sup> stated the belief that the sinus cavernosus is compressed, with resultant stasis of the veins, causing papilledema.

A more favored theory is that of Schmitz-Manz, based on the anatomic work of Schwalbe.<sup>17</sup> The latter found a communication between the subarachnoid spaces of the brain and the perichoroidal spaces of the eye by means of the subvaginal space (surrounding the optic nerve). Schmitz-Manz stated the belief that with increased endocranial pressure the subarachnoid fluid is forced into the subvaginal space, resulting in an edema of the nerve head and later causing incarceration and strangulation of that portion. He stated also that if there is any impediment between the two spaces in the foramen opticum (hypophysial tumor) choked disk will not develop even with a high degree of increased brain pressure.

Another mechanical theory was presented by Knies, Behr,<sup>18</sup> Wilbrand<sup>19</sup> and Sanger<sup>20</sup> who stated that the flow of fluid, which physiologically is centripetal (from eye to brain) is slowed and later blocked by increasing brain pressure, causing papilledema and bulging of the

16. von Graefe, A.: Arch. f. Ophth. (pt. 2) 7:58, 1860.

17. Schwalbe, G.: Lehrbuch der Anatomie der Sinnesorgane, Erlangen, E. Besold, 1885.

18. Behr, C.: Klin. Wchnschr. 7:1818, 1928.

19. Wilbrand, H., and Sanger, A.: Die Erkrankungen der Papilla nervi optici, in Die Neurologie des Auges, ein Handbuch fur Nerven- und Augenarzte, Wiesbaden, J. F. Bergmann, 1912, vol. 4, pt. 2, p. 767.

20. Sanger, A.: Neurol. Centralbl. 24:98, 1905.

subvaginal space. This theory was supported by Behr, who found a circular strangulation sulcus on the optic nerve.

A purely hypothetic theory is that of Benedict, who stated the belief that the changes are neurotrophic and due to vasomotor disturbances of the sympathetic nerves.

*Anatomic Relation of the Ear to the Cranial Cavity (Congestive Inner Ear).*—There is still today, after many years, the much discussed question whether there is an open communication between the inner ear and the cranial cavity.

Schwalbe<sup>21</sup> injected methylthionine chloride (methylene blue) under constant pressure into the subarachnoid spaces and found the dye in the perilymphatic spaces of the labyrinth.

Steinbrügge<sup>22</sup> expressed the assumption that there is a communication between the inner ear and the brain by means of the ductus perilymphaticus. The pressure in the endolymphatic space may be less, with resultant depression of Reissner's membrane toward the organ of Corti.

Ostmann<sup>23</sup> stated that the saccus endolymphaticus and the membranous inner ear form a closed intercommunicating system.

Quinke<sup>24</sup> stated the belief that there is direct communication between the subarachnoid spaces and the scala tympani.

Hasse<sup>25</sup> stated that for the flow of perilymph in human adults the internal meatus plays a much greater part than the aquaeductus cochleae.

Rejtoe<sup>26</sup> denied the communication between the cerebrospinal and the perilymphatic fluid. He stated the belief that the perilymphatic fluid is a product of the endolymphatic by osmosis.

Karlefors<sup>27</sup> summarized his great experiments and anatomic studies approximately as follows: Thus formerly (and possibly now) the aquaeductus cochleae had the function of interchange of fluid between the brain spaces and the labyrinth, although in human adults the flow is from the brain spaces into the labyrinth.

Recent workers on this study are T. Kibata,<sup>28</sup> Meurman,<sup>29</sup> Karbowski<sup>30</sup> and Jampolsky.<sup>31</sup> The last stated the belief that the perilymphatic

21. Schwalbe G.: Centralbl. f. med. Wissensch. **7**:465, 1869.

22. Steinbrügge, H.: Arch. f. Ohrenh. **29**:87, 1890.

23. Ostmann, P.: Arch. f. Ohrenh. **24**:35, 1887.

24. Quinke, H.: Arch. f. Anat., Physiol. u. wissenschaft. Med., 1872, p. 153.

25. Hasse, C.: Anatomische Studien, Leipzig, Wilhelm Engelmann, 1873.

26. Rejtoe, A.: Monatschr. f. Ohrenh. **55**:324, 1921.

27. Karlefors, J.: Die Hirnhäuträume des Kleinhirns, Stockholm, P. A. Norstedt & Söner, 1924.

28. Kibata, T.: Ztschr. f. Oto-Rhino-Laryng. (Tokyo), 1927, vol. 33.

29. Meurman, Y.: Acta Soc. med. fenn. duodecim **13**:1, 1930.

30. Karbowski, B.: Monatschr. f. Ohrenh. **64**:687, 1930.

31. Jampolsky, L. N.: Monatschr. f. Ohrenh. **69**:23, 1935.

space can be called a system of sinuses of the subarachnoid space, functioning as outlets for drainage.

*Reasons for Accepting the Analogy.*—Now having presented the anatomic basis, as well as experimental work, I can turn to the arguments of the authors who deny for anatomic reasons the analogy with the choked disk.

In contrast to these authors, I am of the opinion that in certain respects the anatomic relations are more favorable to congestive inner ear. The eighth nerve does not completely fill the internal auditory meatus in the manner in which the optic nerve does its canal; there are numerous perineural and perivascular lymph spaces, which are especially large in the fundus of the internal meatus and in the region of the root of the lamina spiralis ossea. The wall separating the spaces of the scalae is thin and is formed in part by partitions of connective tissue, so that here also one must take into consideration a communication between the cerebrospinal fluid and the perilymphatic fluid of the inner ear. There exists, furthermore, a connection between the ligamentum spirale and the lymph spaces of the modiolus by means of perivascular channels. Therefore, the following pathways communicate between the cerebrospinal fluid and the spaces of the inner ear: the aquaeductus cochleae, the internal auditory meatus, the perineural and the perivascular spaces, the lymph channels of the bony labyrinthine capsule, the spiral ligament and the pacchionian granulations. In my histologic preparations I was actually able to demonstrate congestive changes following these anatomic paths.

Congestive changes in the inner ear can also be readily explained in terms of the blood supply. The internal auditory artery, which is a branch of the basilar artery, forming the circle of Willis, runs to a great extent without branches and then divides into end arteries. Therefore, a venous stasis and compression of the blood vessels of the inner ear are easily possible. The microscopic slides show such changes as engorgement, venous stasis, thrombi and alterations of the walls of the vessels.

Finally, it is known that every disturbance in the circulation of blood in the inner ear leads to changes in pressure, since the capillaries themselves not only serve for nourishment of the tissue but also secrete the endolymphatic fluid.

This secretion occurs in the stria vascularis of the cochlea, so that even the slightest disturbance in the vessels must soon be noticeable in the inner ear. The process is all the more rapid since the membranous inner ear is enclosed in a rigid bone capsule so that changes in pressure could only be compensated by changes in the oval or round windows.

The objection has been brought that clinically choked disks are seen much more frequently than congestive inner ear. This, however, is readily explained. In many cases of generalized endocranial brain pres-

sure choked disk is not seen; furthermore, a small tumor of the brain can often, particularly when it leads to early hydrocephalus internus, produce marked choked disk, while often a tremendous, extensive neoplasm of the brain will be accompanied by slight papillary edema or none at all. It is known also that choked disk can be present without any complaints. This not only holds for the eye, but can be applied to the ear. Instructive in this connection is my case 1 in which, other than tinnitus, a sensation of fulness, slightly shortened bone conduction, no clinical symptoms were seen; while from the standpoint of pathologic anatomy a series of changes had occurred, such as transudation in the cochlear duct, dropsy, edematous infiltration and perineural and perivascular congestion of lymph. The lack of corresponding clinical symptoms can be explained by the fact that this congestive process had not as yet damaged the delicate sense epithelium or the nerve ganglion apparatus, although the entire organ of Corti was embedded in transudate. However, no one would deny the presence of anatomic changes in this case, despite the lack of marked clinical symptoms.

Finally it can be added that in an otologic examination one is dependent on the subjective answers of the patient as far as concerns perception of the voice, the tuning forks and the audiometer. In examining the eye, on the other hand, the examiner sees the choked disk objectively.

Now that it has been seen that congestive changes of the inner ear accompany generalized endocranial pressure, it is up to the clinician to discover this condition as early as possible. Furthermore, the investigations show that with long-standing generalized brain pressure damage of the sensitive end organ may occur, leading to ascending degenerative processes.

Drawing the clinical conclusions from these anatomic studies, one must bend every effort not only to making the diagnosis early but to applying the necessary operative procedure (extirpation of the tumor or decompression). The later such an operation is performed, the more unfavorable is the prognosis functionally. Once a secondary degenerative process takes place in the sense organ, restitution of function is not to be expected.

#### SUMMARY

I. The histopathologic changes in the inner ear in cases of increased generalized brain pressure (as seen in serial sections of 20 petrous bones) can be classified in the following six main groups:

1. Transudation, exudation and lymph congestion (dropsy and edematous infiltration) in the region of the membranous inner ear and the nerve ganglion apparatus (vaginal dropsy of the seventh, eighth and ninth nerves).

2. Hyperemia, hemorrhage, changes in the blood vessels of the membranous inner ear and the petrous bone.

3. Formative changes (ectasia, stenosis and collapse) of the ductus cochlearis, the ductus reuniens and the saccus and ductus endolymphaticus and perilymphaticus.

4. Multiple hernias of the brain, especially on the anterior surface of the pyramids, and in the middle fossa, accompanied by pressure erosion of the underlying bone.

5. Secondary (late) changes: pigmentation, adhesions and degenerative atrophic processes of the sense organ and the nerve ganglion apparatus.

6. Destructive osseous changes (pressure atrophy).

II. The pathways by which the brain pressure is transmitted into the inner ear are the subarachnoid spaces of the aqueductus cochleae, the nerve sheaths in the internal auditory meatus, the pacchionian granulations, the ligamentum spirale, the lymph channels of the bony labyrinthine capsule and the blood vessels.

III. One is justified in drawing an analogy between choked disk and congestive inner ear.

IV. Increased generalized brain pressure may exist over a certain period without damaging the delicate sense epithelium and the nerve ganglion apparatus, even when extensive transudation or exudation is present.

V. Increased generalized brain pressure existing over a long period produces secondary degenerative processes extending from the basis of the cochlea to the top.

VI. It is the duty of the otoneurologist by exact and periodically repeated examinations to discover the earliest stages of congestive inner ear and to give the indications for surgical intervention before irreparable changes occur in the delicate sense apparatus.

27 Bay State Road.

# TOMOGRAPHY AND CANCER OF THE LARYNX

FELIX E. LEBORGNE, M.D.

MONTEVIDEO, URUGUAY

Since 1922, Dr. Henri Coutard has worked in Europe, and Drs. Chevalier and Chevalier L. Jackson, Dr. W. Edward Chamberlain and others in America, on lateral roentgenography, which is helpful in the diagnosis of laryngeal cancer and in giving laryngologists a more precise idea of neoplastic growth and its extension.

But even with the valuable help of lateral roentgenography, laryngologists did not have the means for a complete study; they had only two points of view, laryngoscopic and lateral.

A frontal view, or anteroposterior projection, cannot be obtained by the ordinary roentgenographic technic, because the interposition of the vertebrae prevents one from seeing the anatomic details of the larynx, composed, as it is, of tissues of poor roentgenologic contrast.

With tomography, the new technic, by which roentgenograms can be made selective of different levels or sections of the body, I have been able to obtain a frontal view, or anteroposterior projection, of the larynx, without any interfering shadows of the vertebrae; the epiglottis, false cords, ventricles, true cords and trachea are faithfully presented, as in an anatomic specimen made by the pathologist.

In 1936 I<sup>1</sup> published the first anteroposterior tomograph of the larynx, taken with my original equipment, and called attention to the importance of this new method in the difficult study of cancer of the larynx.

Since then, I have given the subject special attention and presented reports to the Société de Radiologie, Paris, in April 1937 and to the Society of Otorhinolaryngology of the River Platte in January 1937.

Because of the special structure of the larynx, composed of symmetric halves, it is easy to appreciate the importance of an anteroposterior projection, which affords a comparative study of both hemilarynxes on the same film, showing by comparison the difference between the normal and the pathologic details of each side.

This frontal view free of vertebral shadows can be obtained by a simple method in which the patient is not troubled by any preparation or manipulation.

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1. Leborgne, F. E.: *Anl. d. ateneo de clín. quir.*, June 1936.



But I must say that, important as tomography may be, it does not supplant the lateral roentgenogram or the laryngoscopic view; the three examinations are necessary to make a complete study of the organ, and the three views are especially important in making an accurate diagnosis on which to determine the therapeutic indications.

The progress of surgery and radiotherapy, and the close competition of these two methods has put before the laryngologist a new problem,

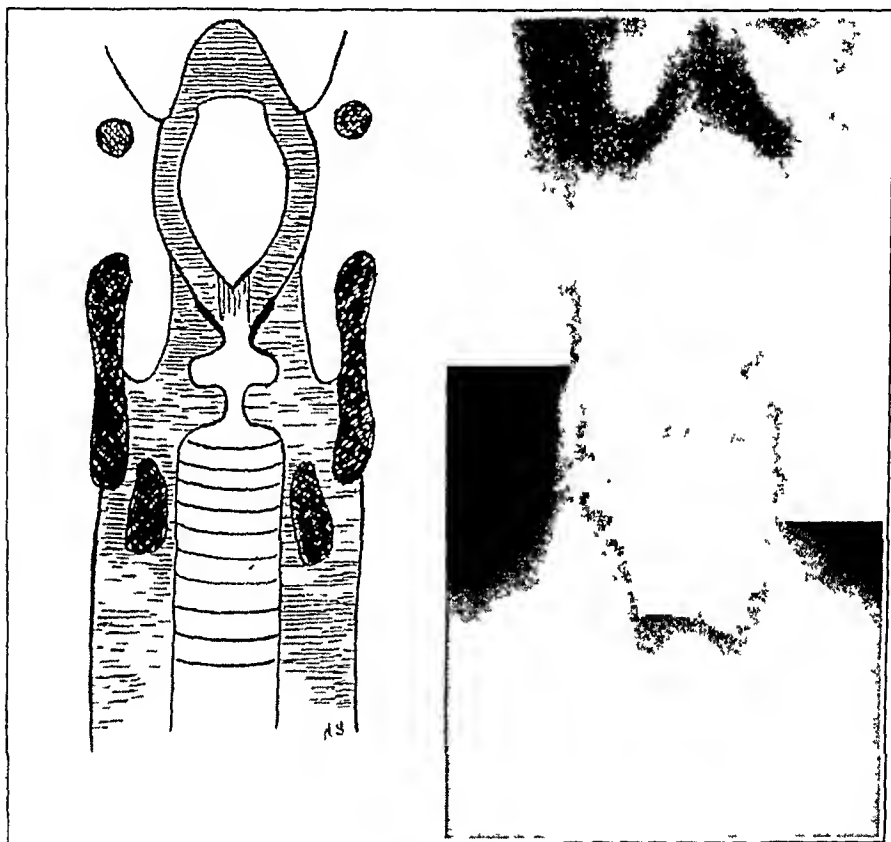


Fig. 1.—Frontal tomograph of a normal larynx, showing the region above the free border of the epiglottis, with the lateral pharyngoepiglottic ligaments, the arytenoepiglottic folds, the laryngeal vestibule and ventricular bands, the ventricles of Morgagni, the two vocal cords, the subglottic region and the tracheal lumen. The negative shadows of the glottic and supraglottic laryngeal lumens together have somewhat the form of a three-leaved clover. The piriform sinuses and the laryngopharyngeal grooves can be well seen. The cartilages appear as if in cross section. The trachea and conus elasticus appear like a candle, the wick of which corresponds to the glottic opening. It should be noted that the printed reproductions are far inferior to the original negative films.

namely, the choice of the best treatment in each particular case. Only a perfect knowledge of the location and extent of the neoplastic invasion will enable him to determine before the operation which of the

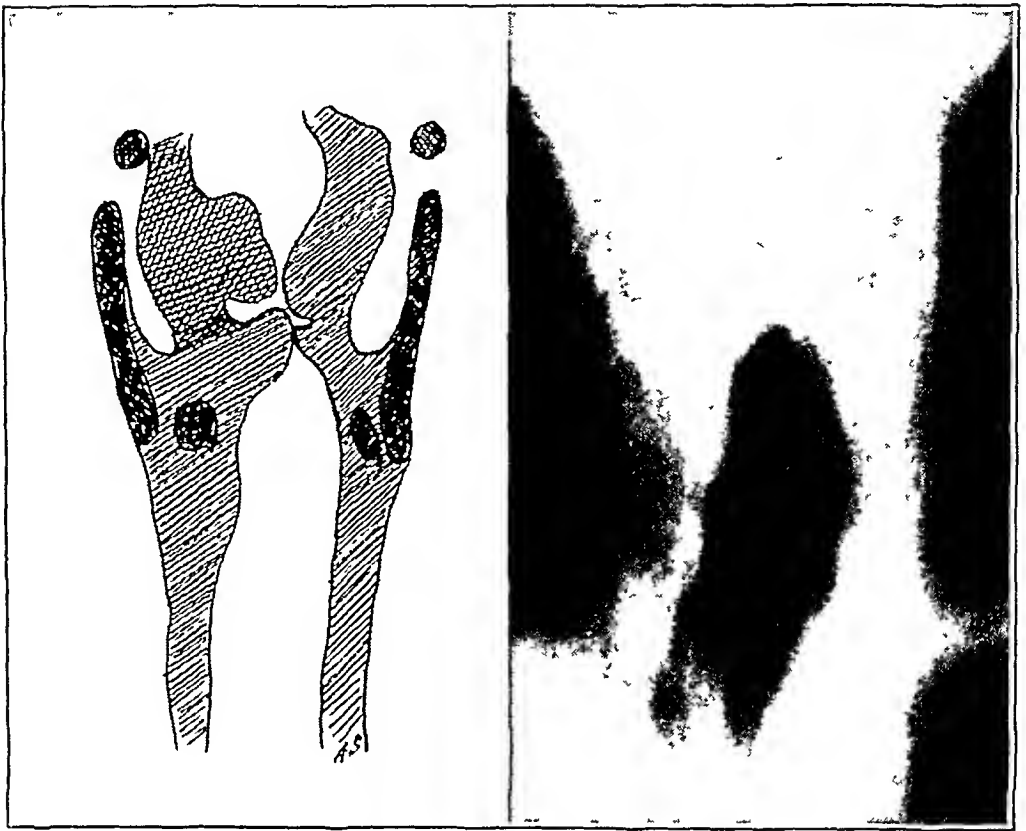


Fig. 2.—Enlarged right ventricular band projecting into the piriform sinus of the same side. The right ventricle is almost obliterated (carcinoma); the right cord is enlarged. The left ventricle is almost obliterated (edema). The patient was operated on by Professor Alonso, and all the roentgen findings were thus confirmed.



Fig. 3.—Epithelioma of the right ventricular band as seen in the mirror. Ulcerated infiltration of the band is visible, with a zone of necrosis next to the epiglottis; the left band is markedly edematous. (The patient was referred by Dr. Apolo.)

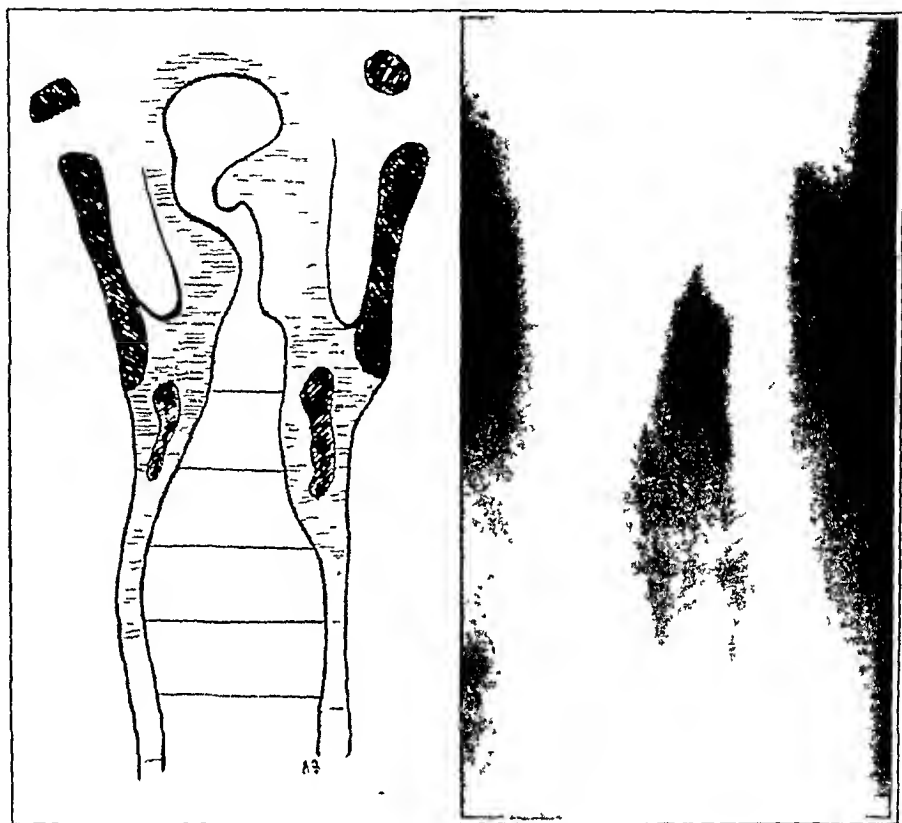


Fig. 4.—Frontal tomograph of the larynx shown in figure 3. The deformity of the laryngeal lumen corresponds with the laryngoscopic image. The ventricles are obliterated.



Fig. 5.—Epithelioma of the left ventricular band, mirror view. (The patient was referred by Dr. Elías Regules.) Slightly productive infiltration was limited to the band, with beginning invasion of the epiglottis. Laryngeal motility was impaired on the left side.

different types of laryngectomy is preferable or whether radiotherapy is advisable. In deciding whether to advise radiotherapy he should give due consideration to the psychic and social effects of the mutilation by surgical treatment of such an important organ as the larynx.

After studying a normal tomographic film, it is not difficult to understand how the neoplasms of the larynx are so clearly visible on the tomographic pictures. Every one knows that lateral roentgenograms clearly show hypopharyngeal tumors and that it is difficult for several reasons thus to study the false cords, ventricles and glottic and sub-

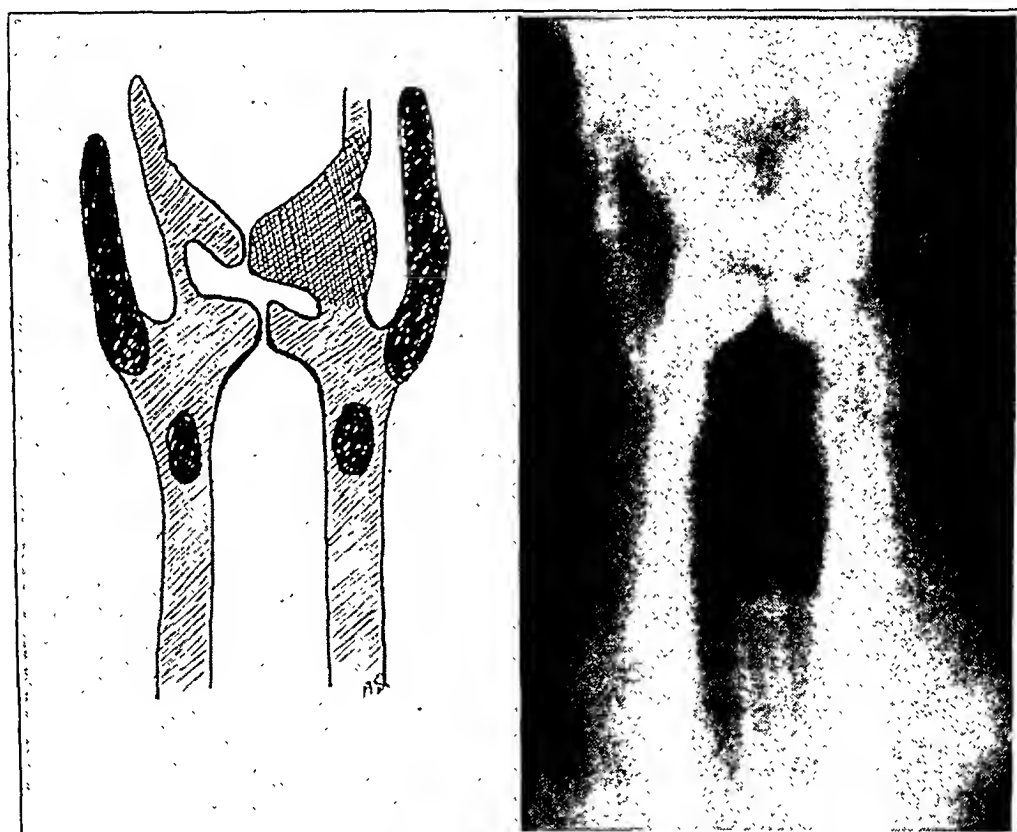


Fig. 6.—Frontal tomograph of the larynx shown in figure 5. The tumor of the band is evident, deforming the laryngeal lumen and filling the corresponding ventricle. There is evidence also of beginning invasion of the left piriform sinus that could not be seen with the laryngeal mirror.

glottic regions; this is where tomography renders the most valuable service.

#### LARYNGOCELE, OR HERNIA OF THE VENTRICLE OF MORGAGNI

Tomography has enabled me to study in a special way a rare disease of the larynx: laryngocele, or hernia of the ventricle of Morgagni. This is extremely important, as this condition can now be differentiated from laryngeal tumor, for which it has generally been mistaken, especially when the herniated tissue has not extended to the soft parts of the neck.

In 3 of the 5 cases I have seen, the condition was not associated with tumor; in 1 it accompanied a tumor of the subglottic region, and in the other, a tumor of the false cord.

The accompanying illustrations show how accurately the diagnosis of laryngocele can be made and how easily the anomaly can be defined. A patient of Dr. Henri Coutard, of the Chicago Tumor Institute, had been treated by roentgenotherapy for a subglottic tumor, which disappeared after five months although a tumor of the false cord remained; ulceration was not visible, and motility was unimpaired. Examination was made with my tomographic equipment, and I obtained interesting tomographs, which were of real diagnostic value.



Figure 7



Figure 8

Fig. 7.—Frontal tomograph of the larynx showing a large tumor of the right side. Note the encroachment on the right piriform sinus.

Fig. 8.—Frontal tomograph showing a laryngocele of the right side of the larynx. Tomography is of great value in diagnosing this condition.

#### TECHNIC

The interpretation of laryngeal tomographs is not difficult, but it is absolutely necessary to have perfect tomographic films, and one has to take several films at different levels, in accordance with certain fundamental principles.

In the first place, the laryngeal cuts must be accurately parallel to the axis of the larynx and trachea, particularly in the study of the subglottic region, because diagonal cuts bring forth apparent alterations of the laryngotracheal lumen due to defective technic. The cuts must be frontal so as to afford a comparative examination of both hemilarynxes on the same film.

These are difficult results to obtain, because the trachea and larynx are not always straight. For this reason skill and training are necessary in order to obtain laryngeal tomographs that fulfil these requirements. Great precision is necessary. Experience is important also in the correct interpretation of the films and especially in differentiating between pathologic shadows and those due to errors of technic.

There are anatomic features that help in interpretation. The cartilaginous elements, the thyroid wing and especially the cricoid ring show the exact level and distance that separates them from the endolaryngeal mucosa.

Certain tomographs may be used and may be valuable for diagnosis even if the picture of the trachea is not quite correct, provided one can differentiate the distortions due to the geometric causes previously explained.

It is absolutely necessary that the tomographic features be compared with those of the lateral roentgenogram and the laryngoscopic view.

It is my opinion that from such a plan of study one can obtain exact and valuable information on the pathologic conditions in a particular case of cancer of the hypopharynx or larynx.

# RADICAL MASTOIDECTOMY

## ITS EFFECT ON HEARING

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AND

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The aural surgeon contemplating the performance of a radical mastoidectomy must ask of himself and discuss with his patient the following questions: What dangers are involved in neglecting the chronic suppuration of the ear? What chances are taken of injuring the facial nerve during the operation? What assurance can be given the patient regarding freedom from aural discharge following operation? What change will there be in the hearing? Much information is available in reference to the first three questions. The otologist can determine with considerable accuracy the imminence of dangerous complications from his knowledge of the progression of pathologic changes involved in the chronic suppurative process. He can assure his patient that, barring rare accidents and unforeseen complications, the facial muscles will retain their normal functions after operation. The pathologic changes manifest in the tympanum, the throat, the nose, the paranasal sinuses and the nasopharynx allow him to venture a shrewd prognosis in respect to the cessation of the aural discharge subsequent to operation. Although none of these questions can be answered definitely and with positive assurance, it seems that the least information is available to assist in determining the effect of the operation on hearing.

Keen<sup>1</sup> investigated the end results in 60 cases of radical mastoidectomy with reference to residual hearing as tested by the use of the watch, the whispered and the spoken voice. In his series of cases a relation between the duration of the chronic suppuration of the middle ear and the postoperative hearing was not apparent. He complained that many recorded preoperative hearing tests were valueless because of the great variation in results produced by a small amount of discharge in the middle ear. It was found that patients presenting gross evidence of cholesteatoma in the middle ear had the poorest preoperative hearing, and the least residual postoperative hearing was in persons

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From the Department of Otolaryngology, University of Michigan Medical School.

1. Keen, J. A.: An Investigation of the End Results of Sixty Cases of Radical Mastoid Operations with Special Reference to Hearing, *J. Laryng. & Otol.* **41**:145 (March) 1926.

with decreased bone conduction. Keen concluded that the main factor influencing postoperative hearing following radical mastoidectomy was the type and amount of tissue covering the promontory. The best postoperative hearing was obtained for patients with a thin, reddish, dry lining of the radical mastoidectomy cavity. The poorest hearing was found in those with an open eustachian tube and a moist thick lining of mucous membrane in the middle ear.

White,<sup>2</sup> in reporting on 100 radical mastoidectomies, stated that 57 of the cavities were dry and well epidermized, 22 were moist and 21 had granulation tissue and a profuse discharge. He determined that his best results were obtained for persons with chronic suppurative otitis media of five to fifteen years' duration. Hearing tests with the whispered and the spoken voice revealed improved hearing in 37, unchanged hearing in 14 and postoperative loss of hearing in 49

Pressman<sup>3</sup> stated that the prognosis for hearing following radical mastoidectomy depends on the state of the auditory nerve, the mobility of the stapes and the opportunity for postoperative care. He reiterated the statement that the better postoperative hearing is to be found in ears with good bone conduction.

Fowler,<sup>4</sup> in presenting 54 cases of radical mastoidectomy in which preoperative and postoperative audiograms were made, maintained that the average radical mastoidectomy does not benefit the hearing. In his series of studies there was an average loss of hearing of 5 decibels in the conversational range. He contended that the modified radical mastoidectomy is of little value in increasing the hearing after long-standing chronic suppuration of the middle ear, because the damage that has been done to the conduction mechanism by the time operation is required is permanent. He made a plea for the avoidance of radical mastoidectomy by early and adequate drainage of acute suppurative processes in the mastoid.

In an effort to gain further knowledge of the effect on hearing of radical mastoidectomy, 50 cases in which the operation has been performed have been analyzed. The tabulated data include the age and sex of the patient, the ear involved, the duration of the otorrhea, the condition of the static labyrinth as determined by caloric stimulation, the preoperative hearing as tested by the whispered and the spoken voice and by the 2-A audiometer and the residual hearing following radical mastoidectomy as tested by the same means. The time after operation that the final tests were made varied from six months to

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2. White, L. E., Jr.: Radical Operation of the Mastoid, *Arch. Otolaryng.* 8:32 (July) 1928.

3. Pressman, J. J.: Residual Hearing After Radical Mastoidectomy, *Laryngoscope* 41:808 (Dec.) 1931.

4. Fowler, E. P.: Hearing Before and After Radical Mastoidectomy, *Arch. Otolaryng.* 26:387 (Oct.) 1937.



two years. At the time of the final hearing test 84 per cent of the ears were dry and completely healed while 16 per cent showed some mucous discharge from the eustachian tubes and were labeled tubal ears, although it was too early in some of the cases to abandon hope of obtaining a dry ear eventually. The 50 cases reported are not chosen cases; they are consecutive in the sense that they are those of the 50 persons who were able to return to the clinic for check-up hearing tests of 100 consecutive patients submitted to radical mastoidectomy who were requested to return for them.

From the compiled data, an analysis of the cases was made in order to demonstrate possible significance in the following relations:

- I. The duration of otorrhea to the preoperative loss of hearing.
- II. The age of the patient to the postoperative residual hearing.
- III. The duration of otorrhea to the postoperative residual hearing.
- IV. The preoperative labyrinthine response to the postoperative residual hearing.
- V. The time required for complete healing of the cavity to the postoperative residual hearing.
- VI. The preoperative loss of hearing to the postoperative residual hearing.

In the following paragraphs the loss of hearing is the average loss in decibels of hearing for the tones 256, 512, 1024 and 2048 double vibrations per second, the tonal range generally utilized in conversation.

I. The duration of the otorrhea seemed to have little effect on the preoperative loss of hearing. In a group of 12 cases in which the duration of the suppuration of the middle ear was between two and six years, the average loss of hearing in the conversational range as determined by means of the 2-A audiometer was 37 decibels. In the 10 cases in which the duration was between six and ten years, the average loss was 44.9 decibels. The average loss fell to 37.6 decibels in the 7 cases in which the duration was between 10 and 15 years and then rose again to 45.6 decibels in the remaining 21 cases, in which it was of still longer standing. The one finding of significance that is noted in these figures is that in the majority of cases of chronic suppurative otitis media and mastoiditis of such a character that a radical mastoidectomy is indicated the average loss of hearing is between 35 and 45 decibels.

II. A study of the postoperative hearing in the different age groups demonstrates no variation of consequence except in patients over 45. Of the patients under 45 (44 cases), 46.4 per cent showed an average gain of 8.1 decibels; 43.8 per cent had an average loss of 7.6 decibels, and 9.8 per cent suffered no change. Of the patients over 45 (6 cases), however, 1 (16.7 per cent) gained 15 decibels, while 5 (83.3 per cent) suffered an average loss of 16 decibels.

III. The duration of the otorrhea seemed to influence the residual hearing only in the cases in which the discharge was of less than four years' standing. In 7 such cases, an average gain of 1.5 decibels appeared in 28.6 per cent; in 14.4 per cent the hearing remained unchanged, and in 57 per cent an average loss of 10.5 decibels was found. In the remaining 43 cases the figures were not significant, an average gain of 9.8 decibels appearing in 44.4 per cent, an average loss of 8.3 decibels in 48.7 per cent and unchanged hearing in 6.9 per cent.

IV. The preoperative labyrinthine response was noted in 45 cases, in 30 of which a normal response to caloric stimulation was given, there being 4 cases of hyperactivity, 5 of hypoactivity and 6 in which a response could not be obtained. Although greater variations in residual hearing were noted in the cases in which abnormal labyrinthine responses were given, the figures are not of statistical value.

V. The time required for complete healing of the cavity seems, from the figures here available, to have some bearing on the postoperative residual hearing. Of 7 cases in which complete healing occurred in less than eight weeks, an average gain of 12 decibels appeared in 57 per cent and an average loss of 8 decibels in 43 per cent. Although this variation is not remarkable, it does show an increase in hearing which is above the average for the group. Of the 5 cases in which more than twenty-five weeks was required for complete healing, an average decrease in hearing of 7.2 decibels following operation was demonstrated in each.

VI. The most striking figures were obtained from a study of the preoperative loss of hearing in relation to the postoperative residual hearing. Of 11 cases in which there was an average loss of hearing in the conversational range of from 18 to 30 decibels, no postoperative change in hearing appeared in 27.3 per cent, while an average loss of 8 decibels appeared in 72.7 per cent. Not until a preoperative loss of hearing of over 40 decibels was observed did the average gain in hearing exceed the average loss. As the preoperative loss of hearing increased, it was noted that the residual hearing showed greater gain. Of the cases (5 in number) in which the preoperative loss of hearing was between 60 and 70 decibels, an average of 15 decibels in hearing was gained after operation in 60 per cent, while an average loss of but 2 decibels appeared in 40 per cent.

#### SUMMARY

One hundred consecutive patients subjected to radical mastoidectomy were requested to return for check-up hearing tests. Of these 50 have returned to date. An analysis of the cases has been made in an effort to determine what factors, if any, influence changes in the acuity of hearing following operation.

The duration of the otorrhea bore no significant relation to the preoperative loss of hearing in the cases studied.

Patients over 45 in the group studied showed the greatest postoperative loss of hearing.

Residual hearing was found to be considerably diminished in patients in whom the otorrhea had existed less than four years prior to radical mastoidectomy.

Preoperative labyrinthine irritability seemed to bear no relation to postoperative changes in hearing in the cases analyzed.

The figures obtained, although not conclusive, suggested that rapid healing of the wound carries a better prognosis in regard to residual hearing. The cases of extremely slow healing were consistent in the appearance of postoperative loss of hearing.

The greatest postoperative hearing loss was sustained in the cases in which the preoperative hearing was best. Conversely, it was noted that the greatest average postoperative gain in hearing resulted in the cases in which the preoperative loss of hearing was more than 40 decibels in the conversational range.

Of the 50 instances recorded, complete healing with freedom from discharge resulted in 84 per cent; in 16 per cent some mucoid discharge originating in the eustachian tube continued.

In the entire group it was found that in 44 per cent of the cases a postoperative gain in hearing averaging 5.6 decibels appeared, in 8 per cent no change in hearing followed operation and in 48 per cent a postoperative loss of hearing averaging 9.4 decibels was experienced.

#### CONCLUSIONS

Although an analysis of 50 cases does not allow conclusive statements, it is believed that a study of this type reveals information of some value.

Preoperative loss of hearing seems to be determined to a considerable degree relatively early in the chronic suppurative process.

A relatively poor prognosis for residual hearing after a radical mastoidectomy may have to be given to persons over 45 or 50, to those in whom the infection of the middle ear and mastoid is of short duration and also perhaps to those who have comparatively good preoperative hearing as indicated by an average loss in the critical frequencies of less than 25 or 30 decibels.

In the consideration of radical mastoidectomy for a patient in whom the indications for the procedure are clear, the possibility of decreased residual hearing should not act as a deterrent. In the majority of cases the chances that the hearing may be slightly improved or slightly impaired are about equal. In either event the average change is less than 10 decibels.

# VALUE OF ENCEPHALOGRAPHY IN THE DIAGNOSIS OF OTOGENIC INTRACRANIAL COMPLICATIONS

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CHICAGO

Since Symmonds<sup>1</sup> established the syndrome of otitic hydrocephalus, in 1931, a great number of cases have been recorded in the literature which seem to support his conception of an increase of intracranial pressure stimulated by the focus of otitis media in children or adolescents.

The primary symptoms recorded are the increase of intracranial pressure combined with vomiting, papilledema and headaches, while the spinal fluid is always found clear. The majority of patients recover under adequate treatment.

The symptoms which, according to Symmonds, are significant for otitic hydrocephalus are present not only in this entity but also in (1) edema of the brain, (2) swelling of the brain (3) serous meningitis and (4) nonsuppurative encephalitis.<sup>2</sup> All these conditions are occasionally caused by otitis media. A few words are in order to differentiate between edema and swelling of the brain. In swelling of the brain the amount of solid constituents of the cell is increased, the amount of fluid contained remaining unchanged. In edema of the brain the amount of fluid, intracellular and intercellular, is increased as in any other edema. The pathology of the other diseases need not be mentioned except otitic hydrocephalus *sui generis*.

It has been stated that real otitic hydrocephalus can occur only when latent hydrocephalus is present, which may become apparent through the stimulation of the aural disease, and produce the symptoms attributed to this entity.

It is only of late that the technic of encephalography<sup>3</sup> and ventriculography has been employed to ascertain the clinical diagnosis, although

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1. Symmonds, C. P.: Otitic Hydrocephalus, *Brain* **54**:55-71, 1931; Otitic Hydrocephalic and Focal Cerebral Symptoms in Relation to Thrombophlebitis of the Dural Sinuses and Cerebral Veins, *ibid.* **60**:531-550, 1937; Otitic Hydrocephalus: A Report of Three Cases, *Brit. M. J.* **1**:53-54, 1932.

2. Not all authors recognize the existence of otogenic nonsuppurative encephalitis.

3. Jerlang, E.: Otitic Hydrocephalus, *Hospitaltid.* **91**:1028-1040, 1938.

Brunner<sup>4</sup> pointed out the necessity of making use of this diagnostic aid some years ago. A number of case reports<sup>5</sup> show that when intradural surgical intervention was performed in the cases described as those of otitic hydrocephalus a gush of fluid was encountered in opening the subdural spaces but no further pathologic condition was found and recovery ensued. Furthermore, in all the reported cases in which encephalographic examination was performed, enlargement of the ventricles was not found, but there was evidence of an increase of the cisternal spaces, so that it seems that otitic hydrocephalus is more external than internal.

Clinically, it is important to decide whether surgical intervention on the brain is indicated in a case of aural disease with evidence of intracranial pressure, in other words, whether one is concerned with an abscess of the brain or with one of the nonpurulent diseases just mentioned. A further differential diagnosis of any of the complications cannot be decisive, as treatment and prognosis in all these conditions are essentially alike. But even in this respect encephalography is frequently helpful. One is aided in coordinating the procedure with all other signs and symptoms and in being enabled to differentiate otitic hydrocephalus from swelling and edema of the brain and, in turn, these conditions from serous meningitis and nonsuppurative encephalitis. In otitic hydrocephalus there is an increase of spinal fluid either in the subarachnoid spaces (external) or in the ventricles (internal hydrocephalus). Swelling and edema of the brain evidence occlusion of the subarachnoid spaces of the diseased side, the ventricle not being markedly changed. Nonsuppurative encephalitis and serous meningitis do not produce marked changes in the amount of spinal fluid, and the encephalogram probably shows normal findings. In contrast, abscess of the brain produces compression of the lateral ventricle.

In the following description, I wish to report a case in which encephalographic examination performed at the proper time would have

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4. Brunner, H.: Zur diagnostischen Bedeutung der Enzephalographie bei otogenen Hirnkomplikationen, *Wien. klin. Wchnschr.* **47**:199-202, 1934; Otogene intrakranielle Komplikationen, in Bumke, O., and Foerster, O.: *Handbuch der Neurologie*, Berlin, Julius Springer, 1928, vol. 10, pp. 194-267.

5. Ersner, M. S., and Myers, D.: Otitic Hydrocephalus with a Suggestion as to Its Etiology, *Ann. Otol., Rhin. & Laryng.* **45**:553-566, 1936. Scal, J. C.: Otitic Hydrocephalus (Pseudomeningitis): Report of a Case, *Laryngoscope* **42**:936-942, 1932. Smith, C. H.: Otitic Hydrocephalus, with Report of a Case, *ibid.* **44**:931-934, 1934. Garland, H. G., and Seed, G. S.: Otitic Hydrocephalus, *Lancet* **2**:751-753, 1933. Carr, F. C.: Report of a Case of Acute Mastoiditis Complicated by Internal Hydrocephalus, *Laryngoscope* **41**:635-637, 1931. MacAlpine, D.: Toxic Hydrocephalus, *Brain* **60**:180-203, 1937.

prevented intracerebral surgical intervention and in which after the procedure had been carried out some healing influence was evidenced, such as it is known to possess for meningitis and epilepsy.

#### REPORT OF A CASE

M. R., a Negro, 15 years of age, was operated on for acute mastoiditis with recurrent otitis media of the right ear on March 29, 1939. The lateral sinus was exposed, situated directly in the antrum, and was found covered with granulations. However, his progress was uneventful and he was allowed to leave the hospital. On April 19, he reappeared at the dispensary with complete paresis of the right facial nerve. Radical operation on the right ear was performed and the dura exposed in the antrum. Three days later a temperature of 104 F. and horizontal-rotatory nystagmus to the right developed. Spinal puncture gave normal results. The temperature rose during the next few days to 105 F. and decreased slowly under the administration of neoprontosil. During this time the patient was stuporous but showed no further signs of intracranial involvement until May 1. He then had an epileptiform convulsion followed by severe headaches. Spinal puncture on the following day revealed increased pressure but clear fluid; the Pandy reaction was slightly positive, and there were 10 cells. There was slight hemiparesis on the left and choking of the disks from 1.5 to 2 D. Under the impression that an abscess of the right temporal lobe was present, the brain was exposed, but pus was not encountered. Postoperatively, the patient was irritable, and he returned to his previous stuporous condition soon thereafter. Two days later marked disturbance in the coordination of the left upper extremity and flaccid paresis of the arm and wrist developed. There was coarse nystagmus to the right. All reflexes were normal with the exception of the left triceps and radial, which were absent. In addition, the patient complained of a deep pain in his right eye. The following day encephalographic examination was performed to exclude an abscess of the brain. The temperature was around 102 F. during all this time. Slight paresis of the abducens nerve developed on the right side. Nystagmus and choking of the disks persisted, and on May 7 slight twitching and later central paresis of the left facial nerve was noted. The tongue deviated to the left, and the hemiparesis became more marked. There were no pathologic reflexes. A roentgenogram of the cervical part of the spine revealed the existence of a left cervical rib.

As the clinical course still seemed to point in the direction of an abscess of the brain, another encephalographic examination was performed on May 8. Six hours later the patient had three consecutive epileptic attacks of the jacksonian type, confined to the left side. From then on, his temperature returned to normal; all neurologic symptoms disappeared; the choking of the disks subsided rapidly, and recovery was uneventful. Two months after the third operation, the ear was dry and epithelized; the paresis of the facial nerve on the right side was subsiding under faradic stimulation. In both encephalographic examinations, the fluid was found clear; the pressure was increased but otherwise normal. Thirty cubic centimeters was removed in the first and 35 in the second, each amount being replaced by 5 cc. less air. A third filling was performed before the discharge of the patient, about three weeks later.

It seems advisable to discuss the encephalographic findings as one. In all the films one has to differentiate two points, the filling of the ventricular system and that of the subarachnoid spaces. The first filling showed a marked contrast in

the quantity of air contained in the ventricles in the anterior-posterior and in the posterior-anterior position of the head. The right ventricle was better filled than the left, irregular but not markedly enlarged. The subarachnoid spaces did not evidence filling on the right side but revealed excellent filling on the left. The lateral view showed the left ventricle well filled with the exception of the inferior horn, while the middle cella on the right side was incompletely filled. Similar films resulted from the procedure three days later. Encephalographic examination three weeks later, before the discharge of the patient, showed both ventricles ideally equal and the subarachnoid spaces well filled. The incomplete filling of the middle cella of the diseased side observed in the first two encephalographic examinations suggested the presence of a blocking-off process but was only the result of the use of a small amount of air, as with a change in the position of the head air passed freely through the ventricles, while the entire subarachnoid space of the affected side could not be filled by moving the head.

#### COMMENT

In my case, a rise of temperature during two weeks, the increase of leukocytes in the blood, the rise of intracranial pressure, headache, papilledema and, finally, signs of left hemiparesis led to a tentative diagnosis of an abscess of the right temporal lobe. Exploration of the middle fossa was performed under this assumption, but no pus was encountered. Two errors must be admitted in this case, although fortunately they did not cause harm to the patient. 1. An encephalographic examination was not performed before operation. 2. The flaccid paresis of the left arm should not have been accounted for by a central lesion. The first mistake was corrected three days after operation, when abscess of the brain was ruled out. The second point was cleared up when, in looking for possible reasons for peripheral brachial paresis, a cervical rib was discovered. The pressure of the rib on the brachial plexus during the convulsion which preceded the paresis may have caused flaccid paresis of the arm.

Although the focal symptoms persisted and even slight central paresis of the facial nerve developed on the left side, a second encephalographic examination yielding the same results and followed by rapid recovery helped to prove the nonexistence of an abscess of the brain. Whether the recovery was entirely due to the second encephalographic examination is difficult to decide. The favorable turn may have been due to the opening of the blocked arachnoid villi, the drainage of which was interfered with.<sup>6</sup> It is, however, more likely that the irritation of the meningeal vessels and of the brain tissue resulted in an increase in the blood supply to the brain and the removal of toxins and poisons.

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6. Hassin, G. B.: Hydrocephalus: Studies of Pathology and Pathogenesis with Remarks on the Cerebrospinal Fluid, *Arch. Neurol. & Psychiat.* 26:1164-1184 (Dec.) 1930.

No doubt the decrease of intracranial pressure through spinal puncture and exposure of the dura also had some favorable healing effect.

In the diagnosis in my case I can exclude otitic hydrocephalus with some certainty because of the lack of roentgen findings. Nonsuppurative encephalitis does not cause occlusion of the subarachnoid spaces, which occurred in my case. Serous meningitis is evidenced through changes in the spinal fluid. So either swelling or edema of the brain was present, most probably the latter.

Without doubting the existence of true otitic hydrocephalus I should like to suggest that the term should be restricted to that condition proper, which should be differentiated clinically from other entities producing the same symptoms, so as to avoid the great confusion of names to which Williams<sup>7</sup> has recently called attention, all covering the same clinical picture. As encephalographic examination can be performed in cases of increased intracranial pressure of the middle fossa—with which cases alone this discussion is concerned—without harm to the patient, especially if only a small amount of fluid is removed and air is substituted, I believe it is necessary that it be performed routinely in all cases in which a suspicion of cerebral complications within the middle fossa is raised. The diagnostic help in excluding abscess of the brain and differentiating between nonsuppurative conditions is great. For the clinician, of course, the exclusion of abscess of the brain, which in turn excludes the necessity of intracerebral operation, is sufficient. The treatment of all other conditions is essentially alike, viz., clearing up of conditions of the ear and exposure of the dura of the middle fossa more extensively because of the papilledema. The prognosis with such conditions is generally favorable, and the papilledema usually subsides, even if a higher degree is present. This point is substantiated by a case observed at the Vienna Policlinic.<sup>8</sup> This was the case of a girl of 8 years, in which mastoiditis following scarlet fever was accompanied by papilledema of 6 D. The dura of the middle fossa was exposed more widely, and the papilledema subsided to 3.5 D. four days later and disappeared completely within six weeks. The tentative diagnosis in the case at the time was scarlatinal encephalitis accompanied by mastoiditis.

#### SUMMARY

In juvenile or adolescent patients suppurative otitis media, papilledema, headache, vomiting and increased pressure of the spinal fluid can be explained, as described by Symmonds and others, as a result

7. Williams, H. L.: The Underlying Factors Concerned in Otitic Hydrocephalus, *Tr. Am. Laryng., Rhin. & Otol. Soc.* **44**:36-83, 1938.

8. Grabscheid, E.: Scharlachencephalitis, Mastoiditis Concomitans, *Monatschr. f. Ohrenh.* **66**:1133, 1932.



of otitic hydrocephalus but also as a consequence of (1) swelling of the brain, (2) edema of the brain, (3) serous meningitis and (4) non-suppurative encephalitis.

Encephalographic examination should be used routinely to differentiate these conditions from abscess of the brain and also to help in distinguishing between them. As a favorable prognosis results from this procedure, the ventricles can also be filled with air in cases of increased intracranial pressure without harm to the patient, if the necessary precautions are observed and the disease is localized within the middle fossa.

A case is reported in which encephalographic examination if performed at the proper time would have prevented surgical cerebral exploration but when performed later in the course of the disease aided in the making and confirming of the diagnosis and in the improvement of the patient's condition, which was most likely produced by an edema of the brain.

The presence of a cervical rib complicated the clinical picture, producing peripheral brachial paresis. Complete recovery ensued.

The use of the term "otitic hydrocephalus" should be restricted solely to that condition as proved by encephalographic examination.

The prognosis, even with a higher degree of papilledema, is favorable even without much decompression of the brain, as proved in a second case, in which a 6 D. papilledema gave way to normal conditions.

# CONGENITAL FISTULA OF THE NECK COMMUNICATING WITH THE MIDDLE EAR

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Congenital fistula of the neck has been a subject of wide and varied interest in medicine both in the United States and abroad for the past century. During this time it not only has held the academic interest of the embryologist and anatomist but has been a matter of practical concern to the otolaryngologist, the general surgeon and the internist. This is evidenced by a literature replete with contributions, many in the form of excellent monographs<sup>1</sup> from the representatives of these specialties. The purpose of this paper is not to give a comprehensive review of the literature but rather to add to it the report of a more or less unusual case, in which a fistula of the neck communicated with the middle ear. We have had the opportunity to study this case clinically and histologically. In this report an attempt is made to indicate the derivation of this fistula and to correlate the many unusual anatomic features presented.

## REPORT OF A CASE

A 5 month old girl was referred by Dr. S. Karelitz to the pediatric service of the Mount Sinai Hospital because of an infection of the upper part of the respiratory tract. On the day after admission the temperature abruptly rose to 108 F., and the infant died. The cause of the hyperpyrexia was not determined.

At birth a marked deformity of both ears had been observed. During the first few weeks of life the patient had had marked difficulty in feeding, accompanied by regurgitation of milk through the nose and also occasionally through the ears. After this period the feeding had been normal. Pertinent in the family history was the presence of fistulas of the neck in the father, in the father's aunt and in the father's grandmother.

*Physical Examination.*—The appearance of the face was fishlike. The eyes seemed small, the nose prominent and the chin receding. There was a suggestive webbing of the toes. The trunk and extremities were well developed and showed no other abnormalities.

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From the Otologic Service and Department of Laboratories of the Mount Sinai Hospital.

1. Leegaard, F.: Arch. f. Laryng. u. Rhin. 26:125-234, 1912. Marx, H., in Henke, F., and Lubarsch, O.: Handbuch der speziellen pathologischen Anatomie und Histologie, Berlin, Julius Springer, 1926, vol. 12, pp. 609-734.

Both auricles were microtic. The pinna was represented by a heavy, almost ropelike band, in which the helix and anthelix seemed fused and in which the tragus, antitragus and lobule could be but barely identified. The auricle was lower than usual—at the level of the angle of the jaw. Two fistulas communicated with each other on each side of the head (fig. 1). One of these was observed to begin as a small opening in the anterosuperior part of the malformed auricle, close to the external auditory meatus, and to course backward and downward, making its exit in the neck immediately behind and at the lower margin of the auricle. At this site there was a slitlike opening about 1 cm. in length. A probe could be passed between the two orifices. The second fistula extended from the latter orifice medially and forward into the deep structures of the neck. A second probe could be passed into this fistulous tract for about 4 cm. The external meatus in its outermost part seemed well developed; in its deeper portion, however, it was so narrowed that the drum could not be visualized.

*Histologic Examination in Serial Sections of the Right Temporal Bone.*—The external auditory canal was much lower than normal. It was considerably narrowed and tortuous in its course inward. It narrowed to a fine fistulous channel and then widened as it approached the middle ear. It was lined by stratified squamous epithelium, undergoing excessive desquamation. Hair and ceruminous and sebaceous glands beneath the epidermis were clearly demonstrable.

The mastoid was undeveloped. It was comprised of cancellous bone marrow. Pneumatization was not evidenced. The antral cavity was relatively small. It was partially occupied by embryonic mesodermal tissue. The roof of the antrum dipped downward considerably, and the digastric and sternomastoid muscles were inserted relatively high. This resulted in a marked narrowing of the antrum from above downward. There was an acute suppurative process in the antrum with ulceration of the mucosa.

The tympanic cavity was separated from the external auditory meatus by a rudimentary tympanic membrane anteriorly and by a plate of bone posteriorly. The origin of the plate of bone could not be determined. It merged with the tympanic and the squamous portion of the temporal bone. The tympanic membrane was relatively thick. It was lined externally by stratified squamous epithelium and internally by cuboidal epithelium in its posterior portion. Anteriorly, however, in close proximity to the eustachian tube, the lining epithelium reversed itself so that the external layer of the drum was cuboidal and the internal layer was stratified squamous epithelium.

The tympanic cavity also was considerably narrowed from above downward. The floor of this cavity was not comprised in its entirety of bone. The jugular dome, which was relatively small, comprised only the posterior part. Anteriorly the floor was formed by muscle tissue, which, because of its high insertion, encroached on the lumen of the tympanic cavity. The ossicles were malformed. The short process of the malleus was inserted on the roof of the external canal. The head of the malleus impinged on the squama of the temporal bone. The head of the incus was ankylosed to the roof of the antrum. Two plates of bone extending from the inner tympanic wall coursed through the tympanic cavity and attached themselves to the squama. The jugular bulb was relatively small and posteriorly was considerably lower than usual.

There was evidence of an acute suppurative process in the middle ear.

A fistulous tract took its origin in the neck below and somewhat posterior to the external canal. It coursed upward, medially and anteriorly and terminated in the

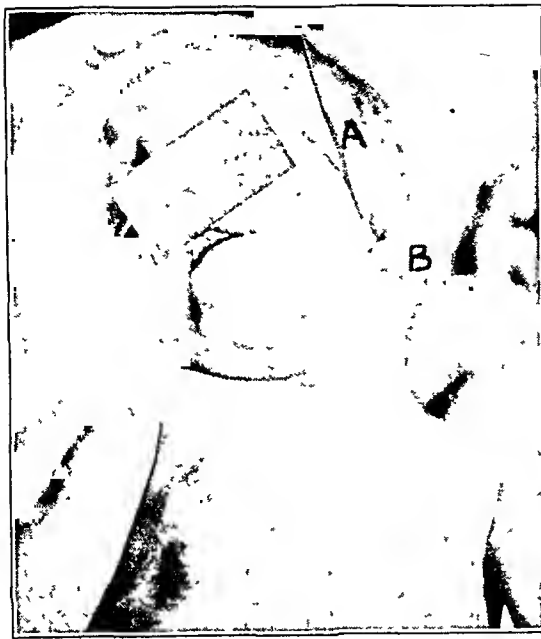


Fig. 1.—Photograph of the infant, showing the malformed auricle with a probe in each of the two fistulas. One probe (*A*), inserted in the auricular fistula, enters in front of the helix and makes its exit just behind and below the auricle. This site of exit is the point of entrance of the lateral fistula of the neck. A second probe (*B*), inserted in this fistula leads into the middle ear. The photograph was presented by Dr. Karelitz.

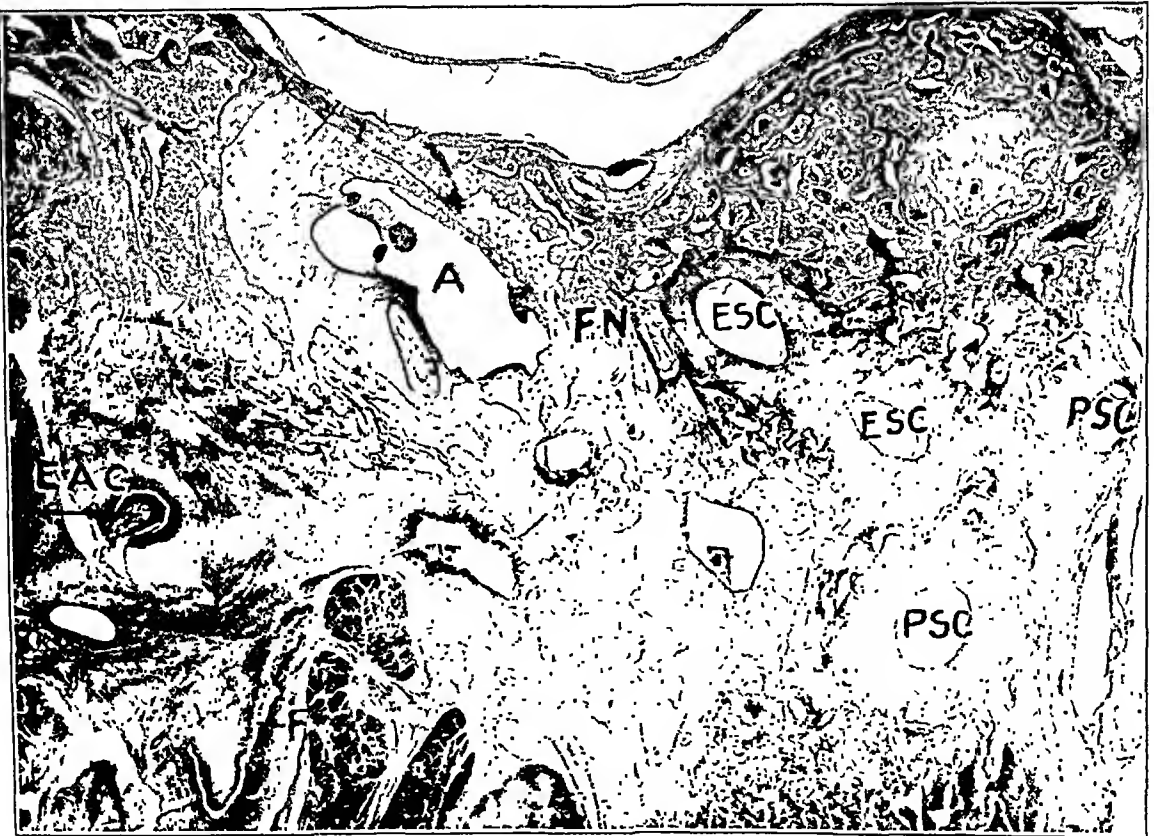


Fig. 2.—Photomicrograph; vertical section through the antrum, showing the lateral fistula of the neck, *F*, close to its external opening. At this site the fistula is bifurcated and Y shaped. The external auditory canal, *EAC*, is considerably contracted and the antral cavity, *A*, narrowed.

*ESC* represents the external semicircular canal; *FN*, the facial nerve and *PSC*, the posterior semicircular canal.

hypotympanum. About midway in its course it divided into two parts (fig. 2), an anterior one, which ended blindly in the neck, and a posterior one, which widened and terminated, as just stated, in the tympanum (fig. 3). The fistulous tract was lined by stratified squamous epithelium undergoing hornification. Beneath the epidermis were seen serous and mucous glands and lymph nodes. As the fistula approached the tympanum it was partially lined by cuboidal epithelium. At that site, however, the inner layer of the tympanic membrane was comprised chiefly of stratified squamous epithelium.

The facial nerve in the tympanum was much lower than usual. Multiple dehiscences in its bony canal communicated both with the dura and with the tympanic



Fig. 3.—Vertical section through the tympanum, illustrating the opening of the fistula into the tympanum. A plate of bone, *B*, ends blindly in the posterior part of the external auditory canal; the malformed ossicles and the formation of new bone may be seen adjacent to the facial nerve.

*EAC* represents the external auditory canal; *ESC*, the external semicircular canal; *F*, the fistula; *FN*, the facial nerve; *I*, the incus; *M*, the malleus; *PSC*, the posterior semicircular canal; *SSC*, the superior semicircular canal, and *T*, the tympanum.

cavity. The chorda tympani nerve could be identified in the external canal but could not be traced in its course through the tympanum.

The bony and the membranous labyrinth were essentially normal.

COMMENT

The outstanding feature in this case was the presence of a lateral fistula of the neck which communicated with the middle ear. Of further interest was the association of this fistula with a second fistula of the auricle and with congenital malformations of the external and middle ears. These anomalies are no doubt intimately related to the embryonic branchial system.

It is not our intention to give a detailed review of the development of the branchial system. The subject has been adequately covered since the original works of Rathke<sup>2</sup> and Ascherson<sup>3</sup> in 1832. It suffices for the purpose of this case report to recall but a few outstanding features.

The first pharyngeal pouch, represented by the eustachian tube and the middle ear, and the first branchial cleft, represented by the external auditory meatus, are the only portions of the branchial apparatus in man which retain in later life characteristics of their embryonic state. The remainder of the branchial system disappears after the first few weeks of embryonic life, giving rise, however, to important structures which persist throughout postfetal life. Failure of proper development of the branchial system results in malformation of these structures and in the formation of congenital branchiogenetic fistulas. With these preliminary statements we can now discuss in a general way the anomalies observed in this case.

I. *Fistula of the Neck Communicating with the Middle Ear.*—Lateral fistulas of the neck are by no means uncommon. They may appear in members of the same family and through three or four generations. The external opening of these fistulas usually appears along the anterior border of the sternocleidomastoid muscle at any level from that of the mastoid tip to that of the clavicle. The internal opening, when the fistula is complete, communicates with the pharynx and is almost invariably in or near the tonsillar fossa. More often the fistula is incomplete and ends as a blind tract in the deeper structures of the neck. It is generally agreed that the fistulas are derived from the branchial system. There still exists a difference of opinion, however, as to the exact site of their origin. Von Kostanecki and von Mielecki,<sup>4</sup> in a comprehensive review of the subject, ascribed it to the second pharyngeal pouch. On the other hand, Wenglowksi,<sup>5</sup> on the basis of his

2. Rathke, cited by Lewis, F. T., and Bremer, J. L.: *Textbook of Histology*, Philadelphia, P. Blakiston's Son & Co., 1927, p. 223.

3. Ascherson, F. M.: *De fistulis colli congenitis adjecta fissurarum branchialium in mammalibus avibusque historia succincta*, Berlin, C. H. Jonas, 1832.

4. von Kostanecki, K., and von Mielecki, A.: *Virchows Arch. f. path. Anat.* **120**:385-436, 1890; **121**:55-87, 1890.

5. Wenglowksi, R.: *Arch. f. klin. Chir.* **100**:789-892, 1912-1913.

painstaking study, stated the belief that they are derived from the embryonic thymic duct, a remnant of the third pharyngeal pouch. Other investigators<sup>6</sup> have implicated other sections of the branchial system. Of especial interest to us, however, are the few reported cases in which the fistulas were considered derivatives of the first branchial cleft. Virchow's often cited case,<sup>7</sup> published in 1865, is a classic example. In this instance the outer opening of the fistula was below and behind a microtic auricle and the inner opening in the nasopharynx, a short distance from the eustachian tube. In König's case<sup>8</sup> also derivation from the first branchial cleft was evidenced; here the external orifice was located at the anterior margin of the sternocleidomastoid muscle about 2 cm. below the auricle. The fistulous tract extended through the substance of the parotid gland and terminated in the external auditory canal.

Communication of a lateral fistula of the neck with the middle ear, observed in the case herein reported, is most unusual. Only 1 similar case, namely, that of Riedel,<sup>9</sup> has to our knowledge been previously reported. In this instance a fistulous tract was resected at operation from the angle of the jaw to the styloid process. Resection of the entire fistula could not be performed, but the belief was stated that on probing 1 to 2 cm. further the middle ear was entered.

A study of the character of the lining epithelium and subepithelial tissue by microscopic examination at times aids in establishing the origin of a fistula. Thus the presence of ectodermal tissue indicates origin from a branchial cleft. On the other hand, the presence of ciliated epithelium only, particularly with underlying lymphoid tissue, suggests that the fistula is derived from a pharyngeal pouch. However, when the fistula is lined by two or more types of epithelium, as in the case described by us, it becomes more difficult to determine its derivation. The presence on histologic examination of stratified squamous epithelium, with its subepidermal structures, lining the fistula in almost its entirety, however, favors origin from a branchial cleft. The close association of the fistula with the malformed parts of the external and the middle ear seems further to localize its origin in the first branchial cleft.

II. *Fistula of the Auricle.*—The communication of a fistula of the auricle with the surface of the neck observed in this case also is most

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6. Carp, L., and Stout, A. P.: Ann. Surg. **87**:186-209, 1938. Hyndman, O. R., and Light, G.: Branchial Apparatus: Its Embryologic Origin and Pathologic Changes to Which It Gives Rise, with Presentation of the Familial Group of Fistulas, Arch. Surg. **19**:410-452 (Sept.) 1929.

7. Virchow, R.: Virchows Arch. f. path. Anat. **32**:518, 1865.

8. König, F.: Arch. f. klin. Chir. **51**:578, 1895.

9. Riedel: Verhandl. d. deutsch. Gesellsch. f. Chir. **26**:125-127, 1897.

unusual. In the vast majority of instances the so-called congenital auricular fistula is in reality a shallow tract which ends blindly.<sup>10</sup> It is the simplest and most common type of developmental abnormality of the external ear. It is believed to be caused by faulty coalescence of the embryonic auricular hillocks first described by His.<sup>11</sup> These hillocks normally arise from the first and second branchial arches and after coalescence assume the form of the auricle.<sup>12</sup> The congenital aural fistula most often is situated at the anterior rim of the helix, is ectodermal and terminates blindly a short distance inward. Rarely is this type of fistula complete. Küttner<sup>13</sup> described an instance in which this condition prevailed. When the fistula is complete its derivation is believed to be from the first branchial cleft rather than from the improper fusion of the auricular tubercles. We are in accord with this view. We are further of the opinion that the auricular fistula in the case reported by us, because of its extent and because of its communication with the second fistula in the neck, can best be explained on the same basis.

III. *Malformations of the Middle and the External Ear.*—The malformations of the external and the middle ear noted in the case under discussion can likewise be attributed to faulty development of the branchial apparatus—the malformations of the external canal, the malleus and incus, the middle ear and antrum and the stapes to faulty development of the first branchial cleft, the first branchial arch, the first pharyngeal pouch and the second branchial arch, respectively.

A review of the congenital anomalies observed in the case described discloses their close embryologic relation, namely, that they are all derived from the first and second divisions of the branchial system.

#### SUMMARY

A case of congenital lateral fistula of the neck communicating with the middle ear is presented with detailed gross and microscopic studies. Other congenital malformations of the external and middle ear, including a fistula of the auricle, are considered. An attempt to correlate these anomalies and to determine their origin is made.

10. Selkirk, T. K.: *Fistula Auris Congenita*, Am. J. Dis. Child. **49**:431-447 (Feb.) 1935. Congdon, E. D.; Rowhanouvougse, S., and Veramisara, P.: Am. J. Anat. **51**:439-463, 1932.

11. His, W.: *Anatomie menschlichen Embryonen*, Leipzig, F. C. W. Vogel, 1885, pt. 3, pp. 211-221.

12. Streeter, G. L.: *Contrib. Embryol.* (no. 69) **14**:111-128, 1922.

13. Küttner, H.: *Deutsche med. Wchnschr.* **39**:489, 1913.



## IS MEDICAL PHONETICS AN ESSENTIAL PART OF OTORHINOLARYNGOLOGY?

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If an otologist thinks of a speech clinic he has in mind a class of stuttering and lisping children under the care of a speech teacher. In literature he finds articles on stuttering and "nervous speech disorders" written by doctors of philosophy and only rarely one by a doctor of medicine. The university speech clinics are as a rule affiliated with departments of public speaking or dramatics or—if the problem is considered medical—connected with pediatrics and consequently run by teachers. The work done by these departments is excellent—there is no doubt about it.

The great question is: Is phonetics a psychologic problem or a medical one which has been neglected by physicians? Two examples from the otologist's practice shall serve to clarify the situation. After thyroidectomy the recurrent nerve can be impacted or stretched or severed. In the case of an impacted or severed nerve the practitioner certainly can try a new operation—with doubtful success, however. He finds the typical primary symptoms of a paralyzed recurrent nerve: hoarseness, high-pitched voice and waste of expiratory air in speaking. And only because he does not consider phonetics a medical field such patients are frequently neglected. With careful treatment vocal functions could have been restored to a great extent.

If one is familiar with the diagnosis of the different rhinolalias one cannot overlook functional weakness of the soft palate. This manifestation effectuates the same speech symptom as does diphtheria, open rhinolalia. The air escapes through the nose because of the deficient closure of the nasopharynx. Enlarged adenoids act as an absorbing medium partially obstructing the passage of the air through the nose. By removing them carelessly one establishes open rhinolalia. Some weeks later the mothers of such poorly speaking children cannot be put off any longer; the children will never speak normally again.

These are two conditions of the many that the phonetician sees in medical speech clinics. They are medical problems which are frequently overlooked or badly taken care of.

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The equipment of a clinic for diseases of speech and voice proves sufficiently its purely medical basis. It consists of the following articles:

1. The regular outfit of an otorhinolaryngologist. It goes without saying that the basic training of a physician for the speech and voice has to be that of an otorhinolaryngologist.

2. The stroboscop. It makes visible both the vibrations and the level of the single vocal cord.

3. The kymograph. It is used as follows:

(a) For the recording of respiration in connection with a thoracic and abdominal rubber belt.

(b) For the recording of articulation. The patient speaks into an English narcosis mask connected by a rubber tube with a Marey tambour. A glass olive is fixed in his nose and by another rubber tube connected with another tambour. Hence one is able to register oral and nasal vibrations of air in speaking. The formation of consonants and vowel waves becomes visible. The instrument records the finest changes in articulation, as seen in the initial stages of multiple sclerosis and general paresis.

(c) For the control of a tone in singing. This registration in connection with the record of respiration gives evidence of many disturbances of the singing voice.

(d) To register the stream of air escaping through mouth and nose in speaking. It measures most exactly the various kinds of rhinolalia in such cases as have been described.

(e) It measures intensity, duration, quality and exactness of sounds. This is important for numerous nervous diseases and furnishes a clue to their diagnosis, e. g., epilepsy, Huntington's chorea and bulbar paralysis.

4. The otophone. When put before the patient's mouth it indicates his kind of abnormal articulation in lisping.

5. The nasophone. It makes audible the stream of air escaping through the nose in rhinolalia.

6. The phonograph recording machine. It serves as a control of diagnosis and therapy. The record is a permanent diagnostic means not unlike a roentgenogram. It permits reexamining a speech or voice symptom as often as necessary. It makes the patient aware of his speaking technic. Moreover, it is a useful device for students, as they can study from it the symptoms of neurologic conditions which otherwise would hardly be available for them.

7. A baby piano or a little harmonium. It helps to classify the pitch of a sound either spoken or sung; e. g., in cases of functional irritation of the larynx in consequence of too low or too high a speaking voice a new natural pitch has to be determined. The patient accommodates his pitch to the one given by the instrument.

8. The oscillograph. It is not necessary, because of its more technical purposes. Its practical value for diagnosis and therapy is not considerable, and it is expensive.

This is the mechanical outfit. The main instrument, however, has not been mentioned yet: the doctor's ear. This ear should be especially good, trained and—if possible—musical. Its sensitivity must be trained just as the student must acquaint himself with the use of a stethoscope. The roentgenologist's eye sees more on a roentgenogram than the lay person's. The phonetician's eye has to learn to decipher kymographic records. Time and experience will teach one how to deal with the more technical problems.

However, there is something more in the work than the skilful mechanical application of the various apparatus. When dealing with neurotic persons, with those presenting problems of behavior, with children with different intelligence quotients or with parents from the psychiatric ward a special training in psychology and psychiatry is required.

#### VOICE

Medical phonetics includes study of the organic as well as the functional vocal diseases and of vocal hygiene in schools. Important among organic diseases is singer's nodes. It is known that it does not help only to remove them, because they regrow, unless the cause for their existence, the wrong use of the voice, is removed.

If the shoe presses one must not only cut the corn but also widen the shoe. With the technical means mentioned it is possible to trace and register the incoordinations and to try to correct them.

Many vocal disturbances in all stages of life are results of mutation, or change, of voice. Boys and girls can reveal a prolonged mutation, boys a persistent high pitch—the so-called persistent falsetto voice—without any endocrinologic impairment. Other symptoms of this complex are hoarseness, aphonia and divergence of the chest and head register. Menstruation, pregnancy and senility are likely to cause vocal impairments.

Paralysis of the recurrent nerve can be due to numerous intrathoracic processes, such as gumma, sarcoma, pneumoconiosis and aneurysm, which can hardly be influenced. After thyroidectomy 3 per cent of all patients suffer from vocal defects caused by a lesion of the recurrent nerve. These defects can be treated successfully with phonetic procedures.

Laryngectomy, laryngofissure and resection of the vocal cords have presented new tasks for the phonetician. The esophagus and the stomach have to replace the lungs. The laryngectomized patient has to learn to swallow air, in order to develop eructation, first into a single sound and in the end into a sentence. Some patients without a larynx even learn to sing.

The functional vocal diseases are often professional. Phonastheny (weakness of voice) with its symptoms of hoarseness, tiredness and nervousness is found in singers as well as speakers. If laryngitis is wrongly diagnosed and the vocal cords are treated—or rather mistreated—with silver nitrate or if one advises the patient to take a vacation and rest his voice, he will come back, his voice rested, and start his professional talking with the same incorrect technic as before. Some weeks later the same trouble will start again, and neither silver nitrate, nor short waves nor vitamin B will give him any relief. The method of choice is phonetic examination and instruction in the physiologic use of the voice.

The impairments of children's voices in schools is due to choral singing. Each child tries to excel his neighbour in intensity of voice. Another cause is the glottic stroke (hard attack of a sound instead of a soft one). To prevent the children from enforcing an exaggerated range in singing the songbooks nowadays are adapted to the physiologically small range of a child. Nevertheless they sing operettas in public schools which surpass their natural capacity.

Singing during mutation is another problem, especially in schools with children of different races. Mutation endangers the larynx and voice and constitutes the basis of many vocal diseases. The handling of this problem in schools is difficult, because, according to their race, children undergo mutation between 9 and 15 years of age. During this time, then, one group of children needs special vocal care.

#### SPEECH

Speech problems occur more frequently in clinics than voice problems. Many patients belong to the group with pathologic speech development. The first thirty months of life are considered a period of physiologic mutism. If a child between the ages of 2½ and 3 years does not talk, this deficiency is called "prolonged physiologic mutism." If it persists one speaks of "hearing-mutism." This term signifies the lack of a speaking function *in spite of* normal hearing. This is in contrast with deaf-mutism, which signifies the lack of a speaking function *because of* deafness. Hearing-mutism takes normal intelligence for granted—otherwise, the phenomenon is called idiotic-mutism.

Word deafness and mind deafness should be included in this chapter. Both are based on an existing hearing function, which, however, cannot be utilized on account of an assumed anatomic or psychologic lesion. To know these facts is especially valuable for the interpretation of hearing tests. Completely negative responses to a test in a child need not indicate real deafness. It could also be brought about by mind deafness (i. e., the incapability of interpreting noise, sounds and words).

A test often valuable for the differential diagnosis between hearing-mutism and deaf-mutism is Fröschels' "itching reflex," a lid reflex to scratching of the auditory canal, positive with hearing-mutism, negative with deaf-mutism.

The therapy has to stimulate both acoustic concentration and acoustic perception. The value of clipping the frenum of the tongue in order to accelerate the development of speech is only imaginary. The theory of "tonguetie" goes back to Celsus (30 A. D.), to whom the tongue was the speech center. Since brain centers are known it has become ridiculous to try to influence the psychologic factor of the development of speech by applying a pair of scissors.

Functional disorders of speech consist of mispronunciations, non-pronunciations or substituting one letter for another. Lispings can be interdental, addental, lateral or nasal. It is due hardly ever to an anatomic basis (gap between teeth, etc.) but to psychologic reasons or to general articulatory awkwardness.

Stutterers crowd the speech clinics. Their problem has gained popular interest because of the publicity in magazine and newspaper articles. The advantage of these is undoubtedly that the stutterer no longer seems ridiculous. Stuttering being a complex of psychoneurotic and psychologic manifestations it is absolutely necessary that doctors should diagnose the patients. Textbooks of otology contain quotations from psychologists on the nature of stuttering and its neurologic nature, as if medical phonetics did not exist. And the continued use of the terms "stuttering" and "stammering" without any scientific discrimination proves sufficiently the lay character of many publications. To a physician, the repetition of letters or syllables is the manifestation of a clonic spasm, and the pressure symptom, when the patient is unable to start a sound, the manifestation of a tonic spasm.

Stuttering can be explained as the expression of an exaggerated pathologic concentration on the details of speech mechanism. It leads to superfluous muscular strain.

The dogmatic quarrel about the origin of stuttering is only theoretic. The importance of left-handedness has been greatly overestimated. The problem of handedness is by no means new, but has been well known for forty-five years. It is of some significance for about 6 per

cent of all stutterers. In many other cases the condition has to be determined as "associative aphasia," aphasia due to wrong associations of "I cannot speak" or "It does not work." An assumed organic inferiority leads to the term spastic neurosis of coordinations if one assumes a special center for the coordination of syllables.

Another problem closely related to stuttering is paraphrasia praeceps, cluttering, a precipitancy of speech with marked rhythmic impairments. This speech disorder is closely connected with a corresponding disorder of the thinking process.

The otologist is more interested in organic speech defects, e. g., impairments of the soft palate. Open rhinolalia is a symptom of cleft palate or of paralysis after diphtheria, after encephalitis, in bulbar or pseudobulbar processes or in myasthenia gravis and frequently is purely functional without any anatomic lesions.

The diagnosis can be registered by the apparatus described. The therapy is active (exercises) and passive (electric vibration, massage and faradization).

Closed rhinolalia occurs in cases of adenoids or excessive nasal hypertrophy. Mixed rhinolalia is the coincidence of the symptoms of the open and the closed form.

In phonetics mutism is considered the innate incapability of talking. Any loss of a previously existing power of speech must be called "aphasia." Cases of motor and sensory aphasia in children, as well as in adults, offer material to speech clinics that mostly is badly neglected. Patients who have lost the power of speech (physical mechanism) or the faculty of language (psychologic mechanism) by apoplexy have to face a hopeless life because of their incapability of expressing themselves. The therapy consists in reeducation. Some weeks after the occurrence of apoplexy with motor aphasia the phonetician carefully teaches with the help of a mirror the placement of lips and tongue. With sensory aphasia the demonstration of pictures and objects accompanied by their names slowly pronounced helps to rebuild the language and to repair the vocabulary. A close cooperation between neurologic and phonetic clinics should be established for both therapeutic and diagnostic reasons.

Scripture developed the theory that from analyzing records of speech on the kymograph one can establish the diagnosis of multiple sclerosis, of epilepsy and of other nervous diseases, either by counting the vibrations (to find the symptom of the rigid speech melody characteristic of epileptic patients) or by comparing explosions (a patient with dementia paralytica is unable to explode the letter "p" regularly if he repeats it several times).

## CONCLUSION

The more exact methods of modern experimental phonetics, which before have been used only for linguistic purposes, will gradually find their way into the otologist's office. The movements of the larynx, of the palate and of the lips, as well as any air vibrations of voice and speech, can be registered with the same exactness as the electrocardiogram records the auricular and ventricular activity of the heart.

It must be admitted that a great number of the nervous diseases mentioned do not, strictly speaking, belong to the otologist's field. However, these diseases reveal symptoms in the organs of his field, which can only be detected by a thoroughly trained otologist. Parkinson's paralysis, for instance, affects the voice, and one can help to establish a diagnosis by recording the inaudible microscopic tremulous movements of the larynx. Specialists interested in constitutional problems will find that the human voice gives new evidence and furnishes new clues for certain constitutional types. To the different constitutional types (Sigaud, Kretschmer) are correlated different variations of voice. Thus phonetics is able to spread the importance of otorhinolaryngology and may be considered its fruit-bearing branch.

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# OTOSCLEROSIS

## POSTAURICULAR APPROACH IN OPERATIVE TREATMENT

HENRY M. GOODYEAR, M.D.

CINCINNATI

Operative treatment of otosclerosis is attracting considerable interest, but the operative technic by the endaural route as well as by the posterior approach has been so trying and exhausting, the operation often lasting from three to five hours or more, that many aurists have been discouraged from attempting to settle its value for themselves.

Whether operative treatment of the disease will be generally accepted will be known only after more extensive use and experimentation. Canfield<sup>1</sup> is especially to be commended on his recent experiments with labyrinthine fistulas.

I wish to describe a postauricular approach with little or no disturbance of the middle ear, which is reasonably simple to perform, giving an excellent opening in the horizontal semicircular canal by means of an instrument which gives greater ease of control than a gouge or a chisel and which I believe will be more acceptable to most operators than an electric burr. This operation also offers a method, which I shall describe in detail, of securing the thinnest and most approximate membrane that could reasonably be obtained to cover the opening made in the canal.

If local anesthesia is to be used, the patient is given  $1\frac{1}{2}$  grains (0.1 Gm.) of seconal<sup>2</sup> on the evening before operation. Two hours preceding operation 3 grains (0.2 Gm.) of sodium amytal is given by mouth, with a hypodermic injection of  $\frac{1}{4}$  grain (0.02 Gm.) of morphine and  $\frac{1}{200}$  grain (0.3 mg.) of scopolamine hydrobromide. One hour before operation a second hypodermic of  $\frac{1}{6}$  grain (0.01 Gm.) of morphine is given.

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1. Canfield, N.: Labyrinthine Fistulas: Report of Experiments on the Vital Response to Various Methods of Producing Defects in Bone, Arch. Otolaryng. **30**: 50-62 (July) 1939.

2. Seconal is stated by the manufacturer to be sodium propylmethylcarbinyllalylbarbiturate. The preparation has not been considered by the Council on Pharmacy and Chemistry of the American Medical Association.



Locally, a 1 per cent solution of procaine hydrochloride with epinephrine is injected through the skin and the periosteum in the line of incision and along the posterior bony wall of the canal.

Local anesthesia has been recommended for the endaural approach because of the unusually long time of operation and the hope of a response from the patient when the semicircular canal is opened. For the postauricular approach, a much shorter operation, I see no reason why a general anesthetic should not be used if preferred.

With the area under local anesthesia the patient is usually so stuporous that any indication of better hearing, unless volunteered without questioning at the time of the uncapping of the semicircular canal, is not significant.

The incision is carried well posteriorly in the edge of the hair line and not below the tip of the mastoid. The tissues, including the periosteum, are elevated forward, the superior and posterior bony walls of the auditory meatus being exposed.

The cortex is removed by means of a Hudson hand perforator and a burr,<sup>3</sup> the posterior wall of the canal being lowered as the burr deepens the mastoid cavity. The horizontal semicircular canal and the short limb of the incus are brought into view by means of a Spratt curet and a round one.<sup>3</sup>

The soft tissues are carefully separated from the outer portion of the posterior bony wall of the canal, the operator being careful to remove the bone above and below to give the full exposure of the soft tissues which cover the posterior wall. Great care must be taken that the deeper tissues near the posterior tympanum are not disturbed or separated at this time.

Once the posterior soft tissues are exposed in the outer two thirds, a narrow scalpel is used to incise the soft tissues of the posterior wall of the canal through and through at right angles (fig. 1) to the canal 1 cm. from the posterior attachment of the tympanum.

Now the outer part of the canal can be moved forward (fig. 1 C) without danger of any detachment at the annulus tympanicus, a most important precaution.

The rest of the bony posterior wall of the canal is slowly removed from the soft tissues by means of John D. Richards' mastoid curets (fig. 2), which must be perfectly sharp and small or moderate in size. The bone is thinned anteriorly and lowered by shaving from above downward, the upper edge of the bony mastoid cavity being used as a fulcrum (fig. 3).

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3. Goodyear, H. M.: The Radical Mastoid Operation: Use of the Tensor Tympani Muscle in Closing the Eustachian Tube, *Laryngoscope* 49:580-590 (July) 1939.

The posterior bony wall of the auditory canal is lowered to approximately the level of the annulus tympanicus.

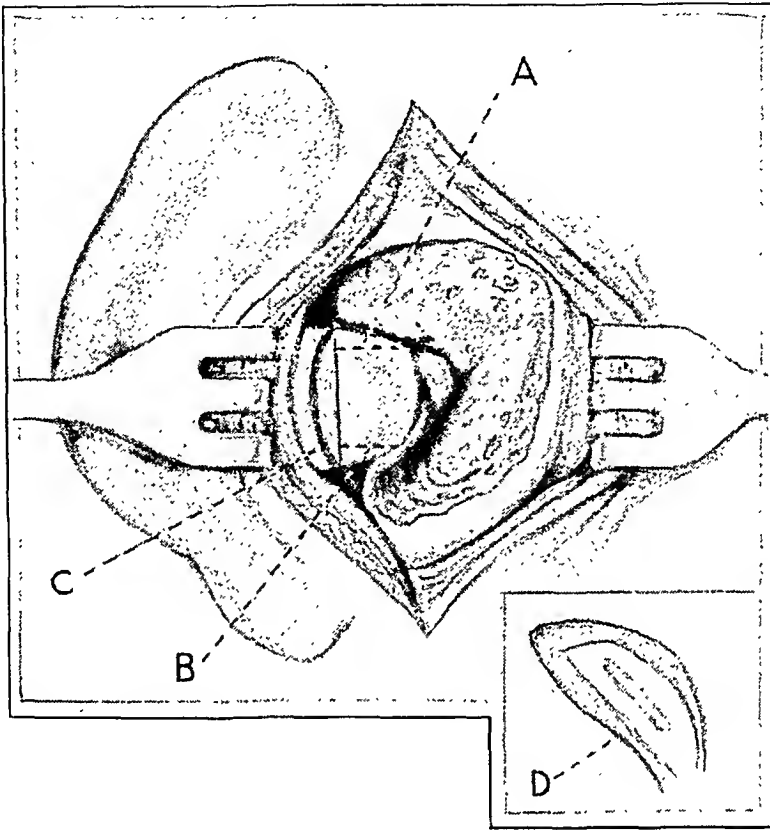


Fig. 1.—Transverse incision and vertical incisions, *A* and *B*, outlining the skin flap. *C*, indicates the freed portion of the auditory canal; *D*, the opening in the external canal.

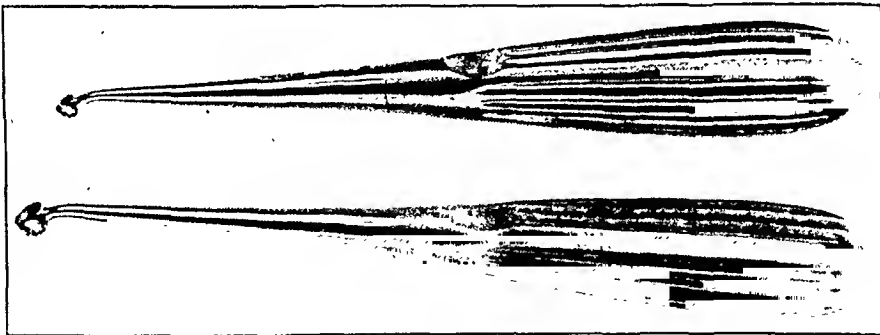


Fig. 2.—John D. Richards' mastoid curets, bent at an angle of 45 degrees, sizes 0 and 2 (Tieman & Co., New York).

With the horizontal semicircular wall of the canal exposed, it is uncapped with a small sharp Richards curet, the operator slowly shaving downward and slightly posteriorly, parallel to the canal, using the upper edge of the mastoid cavity as a fulcrum (fig. 3).

First, a small bluish gray line appears, representing the bony canal, which is outlined for a distance of 3 to 5 mm. The exposure is made the full width of the labyrinthine canal (fig. 1 *D*), and the endosteum is broken, some perilymphatic fluid being permitted to escape. With a magnifying glass the intact membranous labyrinth may be seen.

Vertical incisions (fig. 1 *A* and *B*) are now made in the skin flap, the operator guarding against any pulling that might separate it from the tympanum. This flap is then turned backward and comes to lie firmly over the opening in the horizontal canal (fig. 4).

A small piece of gauze treated with petrolatum or paraffin is placed over the skin flaps and is left in place for eight to twelve days.

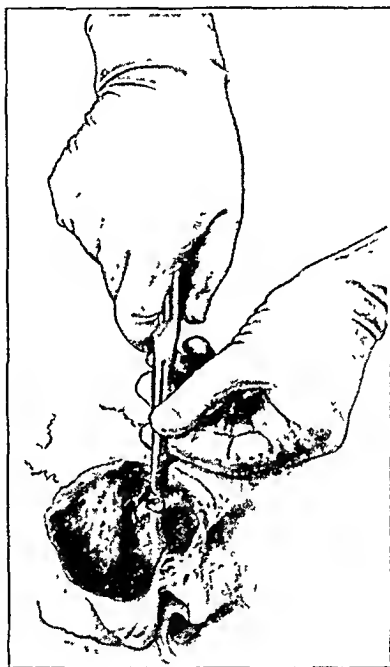


Fig. 3.—Upper edge of the mastoid cavity being used as a fulcrum for a Richards curet.

A circular flap (fig. 5) is cut to enlarge the external auditory canal and is thinned, turned upward and backward and sutured to the periosteum, the fascia or the edge of the anterior skin flap.

The cavities in the mastoid and the ear are gently packed with petrolatum gauze, and the postauricular wound is completely closed.

The packing is not disturbed for seven days, when it is partly removed. It is completely removed by the eighth or twelfth day.

I am not overenthusiastic about the operative treatment of otosclerosis, and it is only by encouraging simpler operative procedures that any great interest and experimentation can be expected in the field.

Jenkins,<sup>4</sup> in his work, opened the horizontal canal twice for a distance of 1.5 mm.; once he left the opening uncovered, and once he covered it with skin from the posterior meatal wall. I have had in my possession from the medical library at Washington a description of his operation, done only once in his career, and no detail of what sort of skin flap he used or how he used it was given. Of course, the opening he made in the canal was insignificant.

I have been unable to find any detailed description in the literature of the proper preparation of a skin flap from the posterior wall of the auditory canal through a postauricular opening that is suitable for this work. The horizontal incision across the soft tissues, which I have pro-

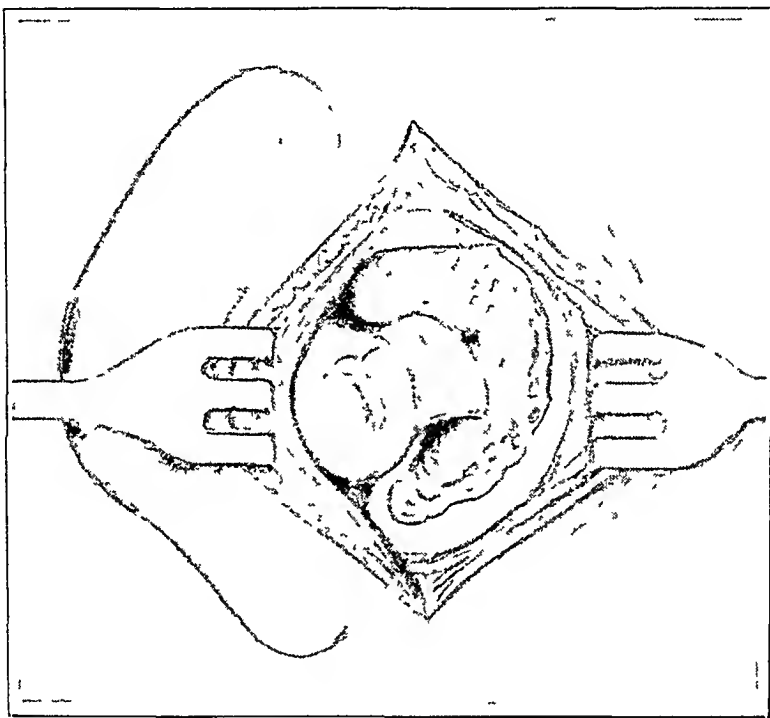


Fig. 4.—Flap turned backward and placed over the opening in the external semicircular canal.

posed, is of paramount importance. Its use along with the Richards curet for the removal of the bone from the soft tissues and for the opening of the horizontal semicircular canal cannot be fully appreciated except in the actual preparation of this exceedingly delicate tissue flap.

I shall quote from Lempert:<sup>5</sup>

The cutaneous lining, which forms the meatal portion of the tympanomeatal membrane and unites this portion with the tympanic portion by extending to

4. Jenkins, G. J.: *Otosclerosis: Certain Clinical Features and Experimental Operative Procedures*, Transactions of the International Congress of Medicine (1913), London, 1914, sect. 16, pt. 2, pp. 609-618.

5. Lempert, J.: *Improvement of Hearing in Cases of Otosclerosis*, Arch. Otolaryng. 28:42-97 (July) 1938.

form the delicate outer cutaneous layer of the tympanic membrane, is very thin. In its extent outward from the margin of the membrana tympani for a distance of about 10 mm. the thickness of the meatal portion varies from 0.01 to 0.03 mm. The tympanomeatal membrane, when completed, is the thinnest cutaneous membrane that could possibly be obtained plastically or grown biologically. It is destined to seal the perilymph space through the window which is to be created in the bony capsule of the external semicircular canal.

I have described a method of obtaining this cutaneous tympanomeatal membrane completely intact, without injury, without severing of the meatal portion from its attachment to the tympanic portion and without perforation of the tympanic membrane, as Lempert<sup>5</sup> specifies as a part of his technic.

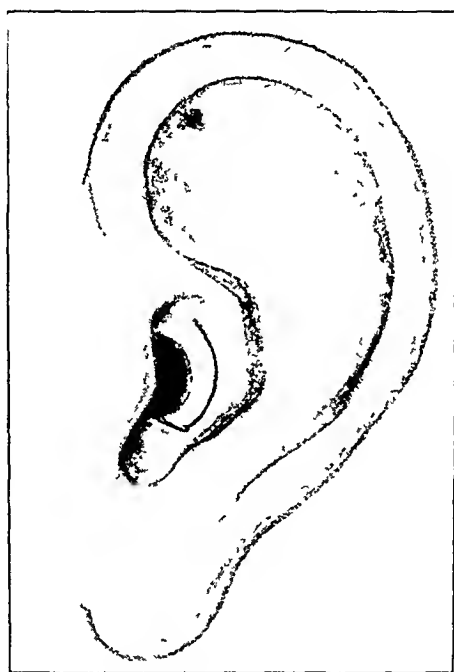


Fig. 5.—Outline of circular meatal skin flap.

Holmgren,<sup>6</sup> by the posterior approach, covered the canal openings with gold leaf, fat, a skin graft, the dura and the mucoperiosteum of the ampulla.

Sourdille<sup>7</sup> performs what he terms a tympanolabyrinthopexy in three principal stages at intervals of four or five months.

6. Holmgren, G.: The Surgery of Otosclerosis, *Ann. Otol., Rhin. & Laryng.* **46**:1-12 (March) 1937.

7. Sourdille, M.: New Technique in the Surgical Treatment of Severe and Progressive Deafness from Otosclerosis, *Bull. New York Acad. Med.* **13**:673-691 (Dec.) 1937.

My work has been done on cadavers. I have used the skin flap twice on the living, once in a modified radical mastoidectomy and a second time to cover an opening which I made in the horizontal canal. The second patient now shows horizontal nystagmus with dizziness on the application of light air pressure to the external auditory canal. Thus, the fistula after three and one half months is still open and highly sensitive to the fistula test.

Lempert <sup>5</sup> stated, "I believe that it is reasonable to assume that a fistula which has not shown signs of beginning regeneration of bone after two months will remain permanently open."

The middle ear is completely sealed off in both my cases in which the skin flap was used, yet the head of the malleus was not removed.

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# PROBABLE PATHOGENIC STREPTOCOCCI AND STAPHYLOCOCCI IN CHRONIC LOW GRADE ILLNESS

AN ANALYSIS OF THEIR FREQUENCY IN THREE HUNDRED AND NINETY-FIVE CASES

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Recently described *in vitro* tests of bacteria<sup>1</sup> have been shown to give results parallel with certain pathogenic properties of the cultures and with other biologic findings.<sup>10</sup> Although cultures reacting positively to these tests are probably pathogenic,<sup>10</sup> for clarity they will be referred

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1. (a) Chapman, G. H.; Berens, C.; Peters, A., and Curcio, L.: Coagulase and Hemolysin Tests as Measures of the Pathogenicity of Staphylococci, *J. Bact.* **28**:343-363, 1934. (b) Chapman, G. H., and Berens, C.: Crystal Violet Agar as a Differential Medium for Staphylococci, *ibid.* **29**:437-448, 1935. (c) Chapman, G. H.: Specificity of the Dye in the Crystal-Violet-Agar Reaction of Staphylococci, *ibid.* **32**:199-205, 1936. (d) Chapman, G. H.; Lieb, C. W.; Berens, C., and Curcio, L.: The Isolation of Probable Pathogenic Staphylococci, *ibid.* **33**:533-543, 1937. (e) Chapman, G. H.; Lieb, C. W., and Curcio, L.: The Use of Bromthymol Blue Agar and Phenol Red Mannitol Agar for the Isolation of Pathogenic Types of Staphylococci, *Am. J. Clin. Path.* **8**:3-11, 1938. (f) Chapman, G. H.; Berens, C.; Nilson, E. L., and Curcio, L. G.: The Differentiation of Pathogenic Staphylococci from Non-Pathogenic Types, *J. Bact.* **35**:311-334, 1938. (g) Rawls, W. B., and Chapman, G. H.: Experimental Arthritis in Rabbits, *J. Lab. & Clin. Med.* **21**:49-64, 1935. (h) Chapman, G. H., and Rawls, W. B.: Studies of Streptococci: I. Qualitative Differences in Resistance to Various Agents, *J. Bact.* **31**:323-331, 1936. (i) Chapman, G. H., and Curcio, L.: Studies of Streptococci: II. Quantitative Differences in Resistance to Sodium Bicarbonate and Hexylresorcinol, *ibid.* **31**:333-337, 1936. (j) Chapman, G. H.; Berens, C., and Nilson, E. L.: Studies of Streptococci: III. Preliminary Attempts to Correlate Resistance to Chemicals, etc., with Pathogenic Effects, *ibid.* **31**:339-346, 1936. (k) Chapman, G. H.: Studies of Streptococci: IV. Resistance of Enterococci, *ibid.* **32**:41-46, 1936. (l) Chapman, G. H.; Stiles, M. H., and Berens, C.: The Isolation and *in Vitro* Testing of Pathogenic Types of Non-Exotoxic Streptococci, *Am. J. Clin. Path.* **9**:20-27, 1939. (m) Stiles, M. H., and Chapman, G. H.: Relationship Between Agglutinability and Certain *in Vitro* Tests of Staphylococci, Streptococci and Colon

(Footnote continued on next page)

to as "in vitro positive" rather than "probable pathogenic." The development of these tests has made possible the study of the relation of large numbers of staphylococci and streptococci associated with chronic, and sometimes with acute, illnesses. In the investigation to be discussed the methods were used in the study of the distribution of probable pathogenic staphylococci and streptococci in patients with low grade chronic illness. Observations on the distribution of the sedimentation rates and nonfilament-filament ratios of 292 of these patients have been reported.<sup>2</sup>

#### MATERIAL

Of the 395 patients studied, most of them showed more than one disease, 96.3 per cent had clinical evidence of involvement of the nose or nasopharynx; 52.2 per cent had classic evidence of chronic sinusitis, and 44.1 per cent had symptoms of the condition which has been called "chronic nasopharyngitis" by Burbank<sup>3</sup> and "sinusitis" by Chase.<sup>4</sup> There were 31 cases of tonsillitis and 17 of other types of oral infection. (Most of the patients had been subjected to tonsillectomy and had received satisfactory dental care.) Bronchitis was present in 83 cases, colitis or irritability of the colon in 67, recurrent or chronic gastroenteritis in 89, symptoms referable to the biliary tract in 82, inflammatory conditions of the urinary tract in 38, rheumatoid arthritis in 16 and other forms of arthritis in 38. A group of 52 patients, who had symptoms which have been called "prodromes to arthritis"<sup>5</sup> were classified as having "rheumatism."

Of these conditions, which are more or less generally considered secondary to infectious processes, at least one was present in each patient studied. In addition, in the group there were 22 patients with asthma, 18 with duodenal ulcer and 22 with migraine.

The patients were classified according to the severity of illness as having symptoms which were mild or recurrent, moderate, severe or acutely exacerbated.

#### METHODS

Cultures of material from the nasal and oral cavities were made for all subjects. Cultures of the feces were made for all but a small number.

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Bacilli Isolated from Persons Suspected of Having Chronic Infection, *J. Lab. & Clin. Med.* **24**:620-623, 1939. (*n*) Chapman, G. H., and Berens, C.: Comparison of Intradermal Tests with Agglutinability and Certain in Vitro Tests of Streptococci, Staphylococci, Micrococcus Catarrhalis and Colin Bacilli Isolated from Persons Suspected of Having Chronic Infection, *ibid.* **24**:601-604, 1939. (*o*) Chapman, G. H.; Berens, C.; Lieb, C. W.; Rawls, W. B., and Stiles, M. H.: Examination of Cultures from Persons Suspected of Having Chronic Infection, *Am. J. Clin. Path.* **9**:491-503, 1939.

2. Stiles, M. H.: Sedimentation Rate and Nonfilament-Filament Ratio in Low-Grade Chronic Illness, *Arch. Int. Med.* **63**:664-678 (April) 1939.

3. Burbank, R.: Etiology and Treatment of Chronic Arthritis, *J. A. M. A.* **99**:1489-1494 (Oct. 29) 1932.

4. Chase, W. D.: Etiology and Diagnosis of Sinusitis, *Pennsylvania M. J.* **39**:389-395, 1936.

5. Hench, P. S.; Bauer, W.; Fletcher, A. A.; Ghrist, D.; Hall, F., and White, P.: The Present Status of the Problem of "Rheumatism," *Ann. Int. Med.* **8**: 1495-1555, 1935.



Because there was no essential difference between cultures of material from the right and from the left naris of a patient, between those of material from the right and from the left tonsil or between those of material from the tonsils and pharynx, indicating intermixing of the flora throughout a rather wide area, the cultures of material from these parts are listed as of material from the oral or from the nasal cavity. Material for cultures was taken from the nasal cavity by passing the swab as far back as possible and from the gingival margin, tonsillar fossae, pharynx and nasopharynx. In collecting specimens of feces, patients were given a laxative pill. The soft, mushy specimen was mixed with a little water and put in a test tube. A plug of absorbent cotton was forced through to the bottom of the tube, filtering the specimen. Serial dilutions were plated on blood agar, bacto tryptose agar being used as a base medium.<sup>11</sup>

In vitro positive staphylococci were isolated by the method of Chapman, Lieb, Berens and Curcio.<sup>14</sup> In vitro positive streptococci were isolated by the method of Chapman, Stiles and Berens.<sup>11</sup>

The methods for the differentiation of pathogenic from nonpathogenic types of staphylococci have been summarized recently.<sup>14</sup> For simplicity in tabulation, strains that coagulated human or rabbit plasma within twenty-four hours<sup>6</sup> were considered in vitro positive.

Smooth strains of streptococci which were resistant to the "bactericidal" action of fresh, diluted, defibrinated guinea pig blood<sup>7</sup> or were resistant to the action of critical time/dilutions of sodium bicarbonate and hexylresorcinol<sup>8</sup> were considered in vitro positive. Enterococci were disregarded.<sup>9</sup>

Because only in vitro positive staphylococci and streptococci were considered in tabulating the findings, they will be referred to simply as staphylococci or streptococci.

## RESULTS

*Streptococci.*—Of the 395 patients, 98.7 per cent yielded streptococci in at least one of the cultures. They were found most frequently in the oral cavity and least frequently in the nasal cavity (table 1). Alpha types were most common, being present in the oral cavity in 96 per cent of the cases. Beta strains were recovered in 9 per cent (table 2).

*Staphylococci.*—Staphylococci were found in 69.8 per cent of the 395 patients. They occurred most frequently in the nose and least frequently in the feces. Because most pathogenic staphylococci are of the aureus type it was expected that aureus strains would predominate. However, 18.5 per cent of the patients had nasal strains, and 10.9 per cent had oral strains of the albus variety (table 2).

*Frequency.*—When the cultural findings were analyzed on the basis of the clinical condition, there was a direct relation between the severity

6. Chapman, Berens, Peters and Curcio.<sup>1a</sup> Chapman, Lieb, Berens and Curcio.<sup>14</sup> Chapman, Berens, Nilson and Curcio.<sup>14</sup>

7. Rawls and Chapman.<sup>15</sup> Chapman and Rawls.<sup>1b</sup> Stiles and Chapman.<sup>1m</sup>

8. Chapman and Rawls.<sup>1b</sup> Chapman and Curcio.<sup>11</sup> Chapman, Berens and Nilson.<sup>1j</sup> Chapman, Stiles and Berens.<sup>11</sup> Chapman and Berens.<sup>1n</sup>

9. Chapman.<sup>1k</sup> Chapman, Stiles and Berens.<sup>11</sup>

of symptoms and the proportion of patients with streptococci in more than one cultural source (table 3). Those with severe symptoms were more likely to have fecal streptococci in addition to the oral strains. The incidence of nasal streptococci increased to a lesser extent (table 4). There was also a tendency for the patients with severe conditions to

TABLE 1.—*Incidence of in Vitro Positive Streptococci and Staphylococci in the Nose, Oral Cavity and Feces*

Source	Streptococci		Staphylococci	
	Number	Percentage	Number	Percentage
Nose.....	30	7.6	233	59.0
Oral cavity.....	384	97.2	195	49.4
Feces.....	127	32.2	23	5.8

TABLE 2.—*Distribution of Types of in Vitro Positive Streptococci and Staphylococci*

Source	Streptococci						Staphylococci			
	Alpha		Beta		Gamma		Albus		Aureus	
	No.	%	No.	%	No.	%	No.	%	No.	%
Nose.....	17	4.3	6	1.5	8	2.0	73	18.5	176	44.6
Oral cavity.....	380	96.2	37	9.4	140	35.4	43	10.9	159	40.3
Feces.....	107	27.1	7	1.8	46	11.6	6	1.5	18	4.6

TABLE 3.—*Relation Between Severity of Symptoms and Incidence of in Vitro Positive Streptococci and Staphylococci*

Type of Symptoms	No. of Cases	Per Cent of Cases in Which In Vitro Positive Organisms Occurred in More than One Cultural Source	
		Streptococci	Staphylococci
Mild.....	174	32.2	47.2
Moderate.....	156	35.2	48.2
Severe.....	45	48.9	44.5
Acutely exacerbated.....	20	65.0	45.0

Note.—When staphylococci occurred, they usually were present in both the nasal and the oral cavity, whereas streptococci occurred more frequently in the oral cavity alone. Hence, the percentage of cases in which positive staphylococci occurred in more than one source was relatively high in all groups.

have a richer flora of streptococci. Of the patients with mild symptoms only 10 per cent had abundant streptococci, compared with 16 per cent of those with moderate symptoms, 18 per cent of those with severe symptoms and 30 per cent of those with acutely exacerbated symptoms.

There was no constant relation between the incidence of staphylococci and the clinical severity, although there was a tendency toward a lower incidence in the patients with more severe symptoms (table 3 and 4).

When the frequency of albus and that of aureus strains were compared, the patients with more serious conditions yielded a higher proportion of aureus strains, particularly from the nose.

Patients with acutely exacerbated symptoms had a higher proportion of streptococci, particularly of the beta type, than did those of any of the other groups, and also a higher proportion of *Staphylococcus*

TABLE 4.—*Relation Between Severity of Symptoms and Incidence of in Vitro Positive Streptococci and Staphylococci in Various Sources*

Type of Symptoms	Per Cent of Cases in Which In Vitro Positive Organisms Occurred							
	Streptococci				Staphylococci			
	Nose	Oral Cavity	Feces	Any Focus	Nose	Oral Cavity	Feces	Any Focus
Mild.....	4.0	96.6	31.6	98.9	61.4	48.3	5.7	71.2
Moderate.....	9.6	97.6	28.2	98.1	61.5	51.3	6.4	70.5
Severe.....	13.3	98.7	37.8	100.0	60.0	42.2	6.7	64.4
Acutely exacerbated.....	10.0	100.0	55.0	100.0	50.0	60.0	0.0	65.0

TABLE 5.—*Incidence of in Vitro Positive Streptococci and Staphylococci When Observations Were Distributed According to Clinical Diagnosis*

Clinical Group	No. of Cases	Per Cent of Cases in Which In Vitro Positive Organisms Occurred					
		Alpha Streptococci		Staphylococci	Staph. Aureus		
		Nose	Feces	Any Focus	Nose	Oral Cavity	
All cases.....	395	4.3	27.1	69.8	44.5	40.3	
Sinusitis.....	206	5.8	25.2	71.8	43.7	42.7	
Nasopharyngitis.....	174	2.9	31.6	65.5	44.2	36.8	
Tonsillitis.....	31	6.5	25.8	83.0	61.3	58.1	
Oral infection.....	17	11.9	29.4	82.3	47.1	41.2	
Bronchitis.....	83	6.0	21.3	78.7	54.2	45.8	
Colitis.....	67	4.5	47.8	65.6	43.3	43.3	
Biliary tract symptoms...	82	1.2	33.0	70.7	45.2	41.5	
Rheumatoid arthritis.....	16	0.0	37.5	56.3	43.7	18.8	
"Other" arthritis.....	38	2.6	23.7	50.0	39.5	31.6	
"Rheumatism".....	52	3.9	33.5	75.0	51.9	42.3	
Asthma.....	22	4.5	54.6	77.3	45.4	40.9	
Duodenal ulcer.....	18	5.6	33.3	55.6	44.4	16.7	

Note.—Because other groups of organisms showed little variation, only alpha streptococci in nose and feces, total staphylococci, and *Staph. aureus* in nose and oral cavity are tabulated.

The percentages in bold face type are statistically significant, as mentioned in the text.

*aureus* in the nose and throat. However, the number of cases was too small for statistical significance.

When the bacteriologic findings were distributed according to the disease (table 5), a number of variations were found. Patients with sinusitis had a richer flora of streptococci and staphylococci in the nose and throat and a higher incidence of staphylococci but fewer fecal streptococci and staphylococci than did those with nasopharyngitis.

*Staphylococcus aureus* was abundant in the noses and throats of patients with tonsillitis. Those with bronchitis yielded profuse growths of nasal and oral staphylococci.

Patients with colitis had a high incidence of fecal streptococci and *Staphylococcus aureus*. Streptococci were present in the feces in 58.2 per cent of the cases, staphylococci in 12 per cent and either or both organisms in 64.2 per cent. These values were significantly above the average.

In patients with arthritis the incidence of staphylococci was low; they were present in only 56.3 per cent of the patients with rheumatoid and 50 per cent of those with "other" arthritis. More than the average number of patients with rheumatoid arthritis yielded fecal streptococci, while with "other arthritis," mostly osteoarthritis, the number was less than average. With "rheumatism" the incidence of fecal streptococci and of oral and nasal strains of *Staphylococcus aureus* was greater than average.

In cases of asthma the incidence of streptococci was high, the proportion of patients with alpha and gamma streptococci in the feces and of those with gamma streptococci in the nose and throat being higher than in any other group.

#### COMMENT

The incidence of streptococci reacting positively to resistance tests was so high that it may be assumed that in vitro positive (possible pathogenic) streptococci are practically universally present in persons with low grade chronic illness. The finding of increased numbers of in vitro positive streptococci in patients with severe symptoms suggests that these organisms may be significant. That such streptococci may be of pathologic importance was suggested by Rawls and Chapman's<sup>12</sup> observation that bactericidin-positive strains are capable of producing arthritis in rabbits, while other strains either are incapable of producing arthritis or else require larger doses of culture, a longer time and a larger number of injections. Further, testing streptococci by animal injection, Chapman, Berens and Nilson<sup>13</sup> found that in vitro positive strains produced lethal effects in 84.9 per cent of 33 rabbits, while in vitro negative strains produced only 1 death (of questionable significance because it was apparently due to factors other than the pathogenicity of the strain) in 10 rabbits.

If it is assumed that pathogenic streptococci are present in practically all persons with chronic illness and that they may be present in apparently healthy persons, the question arises why these persons should exhibit such varying degrees of health. Varying response to the presence of pathogenic streptococci might be conditioned by noninfectious factors, by the number and the degree of pathogenicity of the streptococci present,

by the number of areas infected and by varying degrees of sensitization to streptococci. The role of sensitization, which has been demonstrated by Baker, Thomas and Penick<sup>10</sup> in the production of experimental carditis in rabbits, has been well reviewed<sup>11</sup> and has been discussed editorially in the *Journal of the American Medical Association*.<sup>12</sup>

While the incidence of streptococci in different clinical conditions varied considerably, the variations were statistically significant only in relation to changes in the severity of symptoms and in cases of colitis and of asthma.

As shown in a previous paper,<sup>2</sup> patients with severe symptoms had higher nonfilament-filament ratios (nonfilament-filament ratio =  $\frac{\text{nonfilamented neutrophils} \times 100}{\text{filamented neutrophils}}$ ) and sedimentation rates than did other patients, with the exception that patients whose symptoms were acutely exacerbated did not have as high sedimentation rates as those with symptoms

TABLE 6.—*Correlation Between Severity of Symptoms, Incidence of in Vitro Positive Streptococci, Nonfilament-Filament Ratio and Sedimentation Rate*

Type of Symptoms	*Per Cent of Cases in Which In Vitro Positive Streptococci Occurred in More Than One Cultural Source	Mean Nonfilament-Filament Ratio*	Mean Sedimentation Rate, Mm. in 1 Hour (Westergren)
Mild.....	32.2	18.56	7.20
Moderate.....	35.2	24.22	19.09
Severe.....	48.9	40.10	39.90
Acutely exacerbated.....	65.0	44.00	9.50

$$* \text{ Nonfilament-filament ratio} = \frac{\text{Nonfilamented neutrophils} \times 100}{\text{Filamented neutrophils}}$$

of longer standing. The incidence of in vitro positive streptococci also paralleled the severity of symptoms and hence the nonfilament-filament ratio and the sedimentation rate (table 6).

The findings in regard to pathogenic types of staphylococci were consistent with those of Hallman,<sup>13</sup> who used the coagulase test, pigment

10. Baker, B. M.; Thomas, C. B., and Penick, R. M., Jr.: Experimental Carditis: Changes in the Myocardium and Pericardium of Rabbits Sensitized to Streptococci, *J. Clin. Investigation* **14**:465-473, 1935.

11. Rackemann, F. M.: Allergy: A Review of Current Literature, *Arch. Int. Med.* **55**:141-167 (Jan.) 1935. Hitchcock, C. H.: Tissue Reactivity to Streptococci and Its Bearing upon the Problem of Arthritis, *New York State J. Med.* **34**: 1022-1027, 1934. Hench, P. S.; Bauer, W.; Ghrist, D.; Hall, F.; Holbrook, W. P.; Key, J. A., and Slocumb, C. H.: The Present Status of Rheumatism and Arthritis, *Ann. Int. Med.* **11**:1089-1247, 1938.

12. Allergic Tissue Cultures, editorial, *J. A. M. A.* **108**:2044-2045 (June 12) 1937.

13. Hallman, J. A.: Pathogenic Staphylococci in the Anterior Nares: Their Incidence and Differentiation, *Proc. Soc. Exper. Biol. & Med.* **36**:789-794, 1937.

production, hemolysis, mannitol fermentation and the crystal violet agar reaction, and of McFarlan,<sup>14</sup> who used hemolysin production, the coagulase test and mannitol fermentation, in studying students and hospital patients.

While the pathologic significance of in vitro positive staphylococci strains is more generally recognized, staphylococci, particularly albus strains, appear to have less significance than streptococci according to the observations reported here. There was considerable variation in the incidence of staphylococci in different clinical conditions, but with the probable exception of the lower incidence in arthritis other than rheumatoid the variations were not statistically significant.

The low incidence of both staphylococci and streptococci in osteoarthritis is consistent with the general belief that in this form of arthritis factors other than infection may be of considerable importance.

#### SUMMARY

Cultures were made on 395 patients with low grade illness, to determine the incidence of streptococci and staphylococci reacting positively to certain in vitro tests. These tests had previously been shown to have given results parallel with certain pathogenic properties of the cultures and were, therefore, considered useful as indicators of probable pathogenicity in an extensive investigation of this type. Adequate animal inoculation tests would have been impractical.

In vitro positive streptococci were found in the oral cavities of practically all the patients. Alpha strains of in vitro positive streptococci occurred in the oral cavity in 96 per cent, beta strains in 9 per cent and gamma strains in 35 per cent of the patients. Fecal cultures were the next most frequent source of streptococci, alpha strains occurring in 27 per cent, beta in 2 per cent and gamma in 12 per cent. In vitro positive nasal streptococci were comparatively infrequent, suggesting that nasal secretions may inhibit the growth of such organisms.

Patients with severe or acutely exacerbated symptoms had more abundant in vitro positive streptococci, present in more cultural sources, than did patients with mild or moderate symptoms. Patients with colitis and asthma had in vitro positive streptococci in more sources than did patients with other diseases.

In vitro positive staphylococci were found in approximately 70 per cent of the patients. They were present in 60 per cent of the nasal cultures and in 50 per cent of the cultures of material from the oral cavity but in only 6 per cent of the fecal cultures. There was a tendency for

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14. McFarlan, A. M.: Incidence of Pathogenic Staphylococci in the Nose, Brit. M. J. 2:939-942, 1938.

in vitro positive strains of staphylococci to occur less frequently in serious conditions, particularly in arthritis, and to occur more frequently than average in sinusitis, tonsillitis and bronchitis, but the variations were of probable statistical significance only for arthritis.

#### CONCLUSIONS

Streptococci reacting positively to in vitro tests which give results parallel with certain pathogenic properties of the cultures were almost universally present in the nasal or oral cavities of a group of 395 patients with low grade chronic illness. The incidence of such streptococci varied with the clinical condition, being significantly greater with colitis and asthma and in cases in which the symptoms were severe or acutely exacerbated.

In vitro positive (probable pathogenic) staphylococci were present in approximately 70 per cent of patients with low grade chronic illness. No significant relation could be found between the incidence of such staphylococci and variations in the clinical condition.

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# THE NEXT STEP IN AUDITORY RESEARCH

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In preparing a discussion of the challenging theme of this symposium, we were guided by an old Greek dictum:

"The rudiments must be strongest."

In the realm of auditory research a multitude of complicated acoustic phenomena is being studied and analyzed for which adequate knowledge of the fundamental principles is not yet available. Therefore, in naming a most desirable "next step in auditory research," a better understanding of the cochlea and its mechanical functioning is chosen without much hesitation. This paper attempts to describe experimental possibilities for the study of the function of the cochlea.

It is evident that the first stages in the process of hearing are physical, the transmission of acoustic energy from the external medium to the nerve endings in the cochlea. It is common to identify the anatomic term "middle ear" with the functional meaning "sound conduction apparatus." Similarly "inner ear" and "sound perception apparatus" are frequently considered synonymous. One should, however, not be deceived by anatomic classification. Certain parts of the inner ear definitely belong to the sound conduction apparatus. The attempt is being made here to describe the mechanical phenomena which occur after the sound enters the inner ear. The investigation can be paradoxically termed "a study of the conduction of sound in the inner ear." The following structures of the inner ear which are important for the mechanism of cochlear stimulation will be considered in this paper:

1. The oval window
2. The round window
3. The intralabyrinthine fluid
  - (a) The perilymph
  - (b) The endolymph

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From the Department of Surgery of the University of Chicago.

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Read before the Section of Psychology of the American Association for the Advancement of Science, Richmond, Va., Dec. 28, 1938.



4. The ligaments of the inner ear
5. The craniolabyrinthine communications
  - (a) The aquaeductus
  - (b) The blood vessels
  - (c) The lymph spaces
  - (d) The internal auditory meatus

It is obvious that not all these structures actually convey the acoustic energy; they do, however, exert an important influence on the conditions of sound conduction in the inner ear.

These anatomic structures are associated with the following functional problems to be dealt with:

The oval window	{	1. The windows as portals of entry for the sound
The round window		2. Hearing in a windowless cochlea
	{	3. Hearing in a cochlea with one window
The intralabyrinthine fluid		1. Hearing under disturbed hydrostatic conditions
	{	2. The intralabyrinthine fluid as a part of the sound conduction system
The ligaments of the inner ear		Dynamic compressibility of the "soft tissues" of the cochlea
The craniolabyrinthine communications	{	1. Static conditions; the question of "glaucoma labyrinthi"
		2. Half static conditions; the canalicular resistance as a function of frequency; limit of hearing for lower tones and sensitivity of the ear in the condition
		3. Dynamic (i. e., acoustic) conditions

These problems were studied in experiments on animals. Our method for objective tests of cochlear function consisted in the observation of the reflex of the acoustic tensor and stapedius muscles. The reflex is a reliable indicator of cochlear function as long as its natural limitations are known and respected.<sup>1</sup> In addition the reflex offers no theoretic difficulties compared with the cochlear potentials or the nerve potentials. Finally, the experiments described in this paper deal with problems which require the inner ear to be opened surgically and functional tests to be performed on a partially opened cochlea. Former tests revealed that the electrical potentials in an opened cochlea behave strangely and seem not to be a true indicator of cochlear function.

The method of conditioned reflexes has shown admirable results. However, for executing experiments a staff of well trained experimenters and an especially equipped laboratory is indispensable. For this reason reliable work on acoustically conditioned animals has been, and can be, done at only a few laboratories.

The objective method of testing function with the acoustic reflex contractions of the muscles of the middle ear differs from the conditioned reflex in that only the lower parts of the acoustic tracts are

1. Kobrak, H.; Lindsay, J. R., and Perlman, H. B.: Value of the Middle Ear Muscle Reflex as Indicator of Hearing, *Arch. Otolaryng.* **21**:663 (June) 1935.

involved in the reflex of the tensor and stapedius muscles. The higher centers and the cortex are not included. The observations on the reflex of the tensor or stapedius muscles require no special training so far as the animal is concerned. Any experimenter familiar with otologic technic is able to do this type of research without further training.

#### THE PORTALS OF ENTRY OF SOUND

Our experimental method has permitted conclusive tests in the animal as to whether sound can enter the inner ear through the round window. In the cat a spacious round window niche permits the introduction of a glass tube into direct proximity with the membrane of the round window. A tube was inserted in the round window niche and sealed. Sound was conveyed through tubes directly into the niche. The stimulation of the cochlea through the round window is suprisingly effective.

This experiment demonstrates that the acoustic energy may enter the cochlea through the round window and may reach the nerve endings through the scala tympani and not, as in the case of ossicular sound conduction, by the way of the scala vestibuli. This phenomenon may be called *reversed sound conduction in the inner ear*.

Experiments in which a similar tube was led into the region of the oval window did not give clear results, probably because of certain technical difficulties. Functional curves demonstrating direct application of sound into the oval window are therefore not available. However, with the tube inserted in the outer acoustic meatus the cochlear function by ossicular conduction can be measured and compared with that by direct application in the round window. The comparison is shown in figure 1.

The next question is whether the cochlea can be stimulated by acoustic energy which does not enter through either window. The question has prompted a heated discussion in the literature on bone conduction. Bezold had maintained that both in air and in bone conduction the cochlea is stimulated by the piston-like movements of the stapes. Other authors stated the belief that in bone conduction the cochlea is stimulated by rhythmic contractions and rarefactions of the otic capsule. Animal experimentation permitted what could be called the "experimentum crucis" in this problem. If Bezold's teaching of exclusive osteotympanic conduction is right, no reflex should be elicited by bone-conducted sounds after extirpation of the stapes. If function is observed, the teaching of osteotympanic bone conduction as the only pathway of bone conduction must be abandoned.

In figure 2, experiments on rabbits are shown in which the stapes has been either destroyed or extirpated.

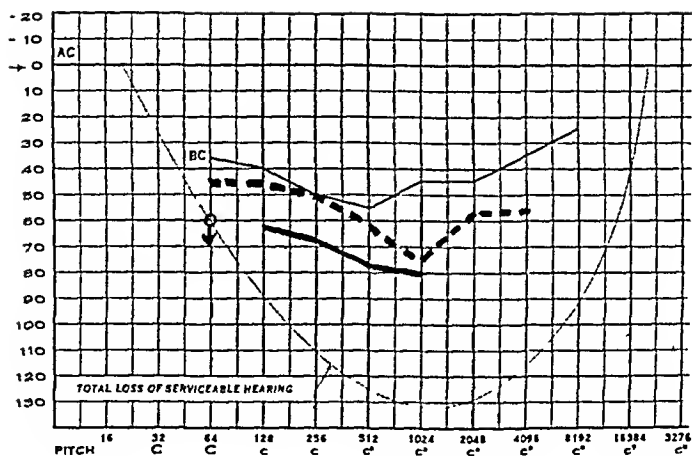


Fig. 1.—Cat; comparison of ossicular sensitivity with aerocochlear sensitivity. The solid line indicates cochlear function by sound conduction through the outer ear. The broken line represents the threshold of hearing by application of sound through the round window.



Fig. 2.—Destruction of the stapes in a rabbit. The footplate is broken. A part of the footplate is pushed into the vestibule. A small hemorrhage is seen in the vestibule. A functional test taken immediately after the destruction of the stapes revealed cochlear function for bone-conducted tones remaining.

The functional tests have to be performed immediately after the operation, because the escape of labyrinthine fluid causes severe cochlear disturbance of its own. After a certain time has elapsed all function is destroyed. Immediately after the extirpation, however, definite function has been observed, showing that *bone conduction is possible without a stapes*.

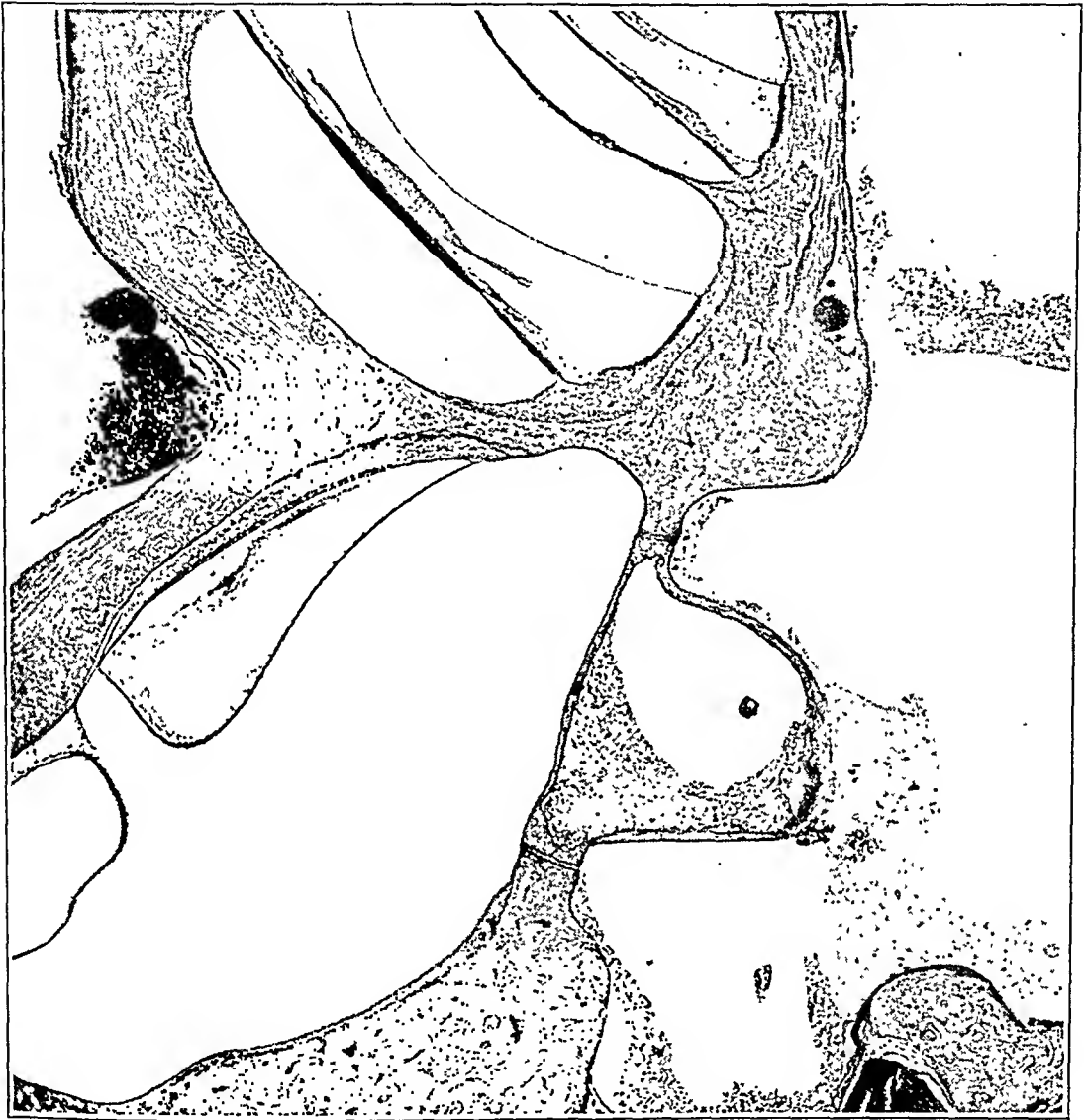


Fig. 3.—Rabbit; plugging of both cochlear windows with plaster of paris; view of the stapes. Functional tests revealed disappearance of the reflex to both air-conducted and bone-conducted sounds. The loss of a large portion of the plaster of paris is unavoidable in the process of decalcification; hence, only fragments remain.

#### HEARING IN THE WINDOWLESS COCHLEA

The following experiments aim to show the elastic qualities of the soft tissues in the cochlea. If the soft tissues in the cochlea are easily compressible, undisturbed function for bone conduction is possible even without cochlear windows.

The problem was studied experimentally by transforming the membranous windows into hard, bonelike structures by application of plaster of paris. The histologic findings are given in figures 3 and 4. The functional result has been clearcut.

When one window only was made rigid, bone conduction remained unchanged or even improved (fig. 5). When the regions of both

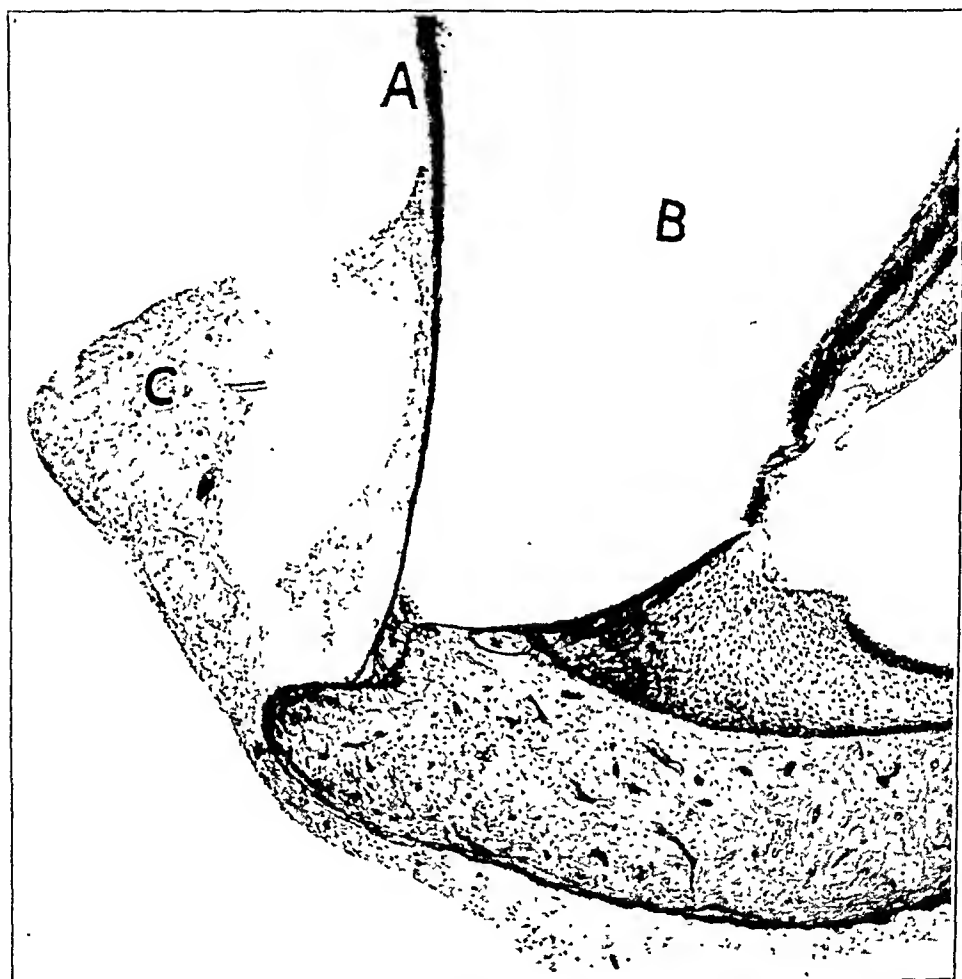


Fig. 4.—Rabbit; plaster of paris in the round window niche. *A*, indicates the round window membrane; *B*, the scala tympani, and *C* the plaster of paris.

windows were made rigid, function could not be demonstrated either by air or by bone conduction.

The experimentation with plaster of paris made a few tests necessary in order to determine the eventual chemical activity of the gypsum. It was to be demonstrated beyond doubt that the plaster of paris deposited in the window niche acted only physically without producing chemical changes in the inner ear. The following experiment seemed to clarify this point. The usual mixture of plaster of paris dries and

hardens in about two or three minutes. The hardening process was watched in the mixing bowl. A mixture of plaster of paris which was softer than usual was introduced into the window niches and the acoustical effect observed. The result was clear. There was no loss of bone conduction as long as the plaster of paris remained soft (over one hour). It is evident, therefore, that the effect of the plaster of paris is physical rather than chemical.

#### THE FUNCTION OF THE INTRALABYRINTHINE FLUID

E. H. Weber, and later Politzer, stated a belief in direct bone conduction, i. e., in the direct conveyance of acoustic energy to the auditory nerve through the lamina spiralis ossea. In the animal experiment it

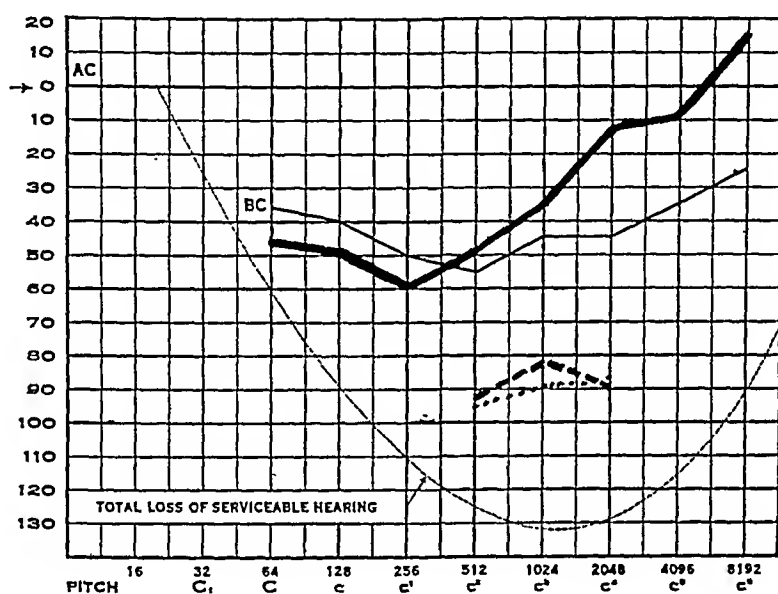


Fig. 5.—Rabbit; the oval window made rigid by plaster of paris. The solid line indicates the normal air conduction curve. The dotted line is the normal bone conduction. The broken line represents the function for bone conduction after the application of plaster of paris.

NOTE: With only one window made rigid, the function for bone conduction is not only unimpaired but even slightly improved.

can be demonstrated that auditory function is possible only in a cochlea in which the labyrinthine fluid is fairly stable. Tapping of the cochlea, resulting in severe loss of endocochlear fluid, destroyed the reflex completely.

Limited lesions in the cochlea, which were permitted to heal, did not disturb the hydrostatic conditions of the cochlea as much as those in the acute experiments. In the case of these healed lesions, function could be demonstrated by means of the reflex.

Direct stimulation of the nerve endings of the acoustic nerve by bone-conducted sound through the lamina spiralis ossea seems to be

impossible. Whatever the pathway is by which the acoustic energy reaches the inner ear, namely, the ossicles, the air of the middle ear or the bone; wherever the sound may enter the cochlea, namely the footplate of the stapes, the round window or the otic capsule, the intralabyrinthine fluid is the last link in the sound conduction system. For this reason it may be called "*the final common path of sound conduction.*"

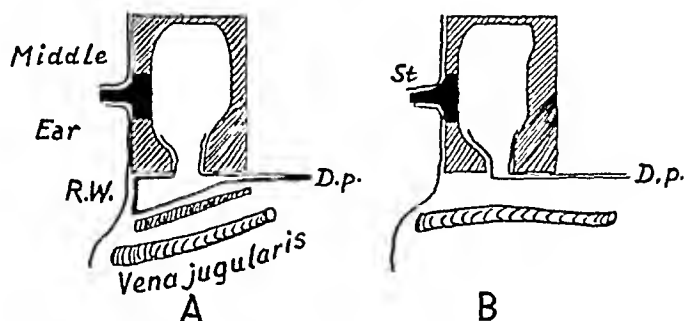


Fig. 6.—Demonstration of the relation between the ductus perilymphaticus and the round window in birds (after Beyer). *B* shows the ductus perilymphaticus (*D. p.*), the only outlet of the inner ear. In *A* the aqueduct has formed a membranous enlargement which reaches the cavity of the middle ear, namely, the round window (*R. W.*).

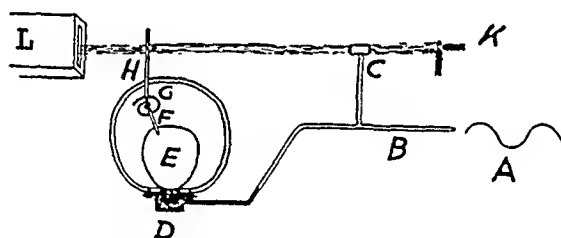


Fig. 7.—Schematic explanation of the method: Sinusoid pressure changes are produced at *A* and led through the tubes (*B*) to both the optical manometer (*C*) and the attachment (*D*). Here the pressure is transferred through a hole in the skull to the cranial cavity (*E*). The attachment (*D*) is put air tight over an opening in the skull. The shaded area in the tube is filled with Ringer's solution. In the cochlea (*G*) is a capillary (*H*), the meniscus of which is optically recorded on the optical kymograph (*L*). The optical system is only shown as the arc lamp (*K*). To be measured are the physical characteristics of the cranialabyrinthine communications (*F*), which anatomically consist of the aqueduct, the blood and the lymph vessels. Recorded by this method are pressure changes in the cranial cavity and the resulting movements of the intralabyrinthine fluid.

#### THE CRANIALABYRINTHINE COMMUNICATIONS

Anatomically the cranialabyrinthine communications consist of the aqueduct, lymph spaces, the blood vessels and the internal auditory meatus. These anatomic structures cannot be treated individually in functional studies. It is more feasible to consider the group of canals as a functional entity, for which the term "cranialabyrinthine com-

munications" may be used. Comparative anatomy as well as physiologic considerations show that they should be considered a "third cochlear window" (fig. 6).

The physical characteristics of this system of canals have been studied by a method illustrated in figure 7.

As demonstrated in figure 8, slow sinusoid pressure changes in the cranial cavity produce rhythmic movements of the meniscus in the cochlear capillary. Even small pressure changes in the cranial cavity produce movements in the labyrinth.

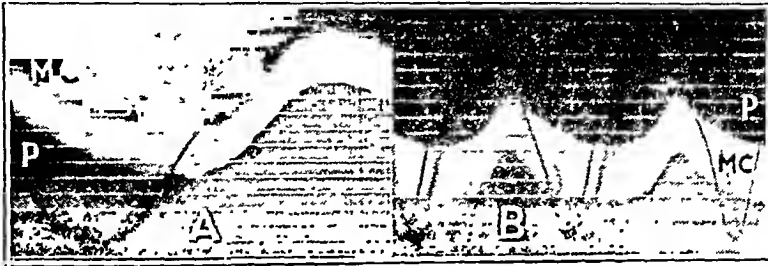


Fig. 8.—Rabbit; capillary in the basal coil of the cochlea; sinusoid pressure changes in the cranial cavity. The labyrinthine fluid moves according to the pressure changes in the cranial cavity. The phase difference is due to the resistance in the craniolabyrinthine canals. The amplitude of pressure is equal in both experiments. The frequency, however, is increased in experiment B. The decrease of the movements of the fluid is due to the increase of frequency. MC indicates the meniscus of the capillary in the inner ear, and P, the pressure in the cranial cavity.

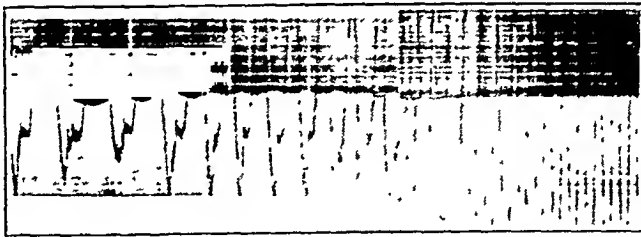


Fig. 9.—Same experiment as in figure 8. The frequency of the pressure changes was increased while the picture was taken. Parallel to the gradual increase of the frequency there is a diminution of the amplitude of the movements of the meniscus. At a certain speed movements of the fluid cannot be recorded; the meniscus appears to be standing still.

A localized increase in pressure in the perilymph without an increase in pressure in the cranial cavity (a condition which in analogy to the eye may be called "glaucoma labyrinthi") is difficult to understand as long as the communications with the cranial cavity are open.

If the frequency of the pressure changes in the cranial cavity is increased (the amplitude of pressure remaining equal) the movements of the labyrinthine fluid are diminished. If the frequency is increased further movements of the fluid cannot be recorded (fig. 9). The



amount of movement of the fluid in the craniolabyrinthine communications shows an important difference between static and dynamic pressure changes. Low pressure changes are easily compensated. For high frequency pressure changes the system shows high resistance to movements of the fluid. In an electrical analogy, the craniolabyrinthine communications act as an inductance coil permitting free flow of direct current but inhibiting alternating current.

This fact may have some bearing on the function of the cochlea, as the following considerations may show:

If the stapes moved with infinite slowness, the difference in pressure between the cochlea and the cranial cavity would be compensated completely by movements of the fluid back and forth through the aqueductus (isotonic conditions in the cochlea).

The opposite extreme is an infinitely fast movement of the stapes. No intralabyrinthine fluid would move through the craniolabyrinthine communications. The vibrations of the stapes would create a maximum of pressure changes (isometric condition in the cochlea).

If it is assumed that isometric conditions in the cochlea are optimal and isotonic conditions least favorable for cochlear function, it is understood why an increase in frequency improves the function of the cochlea. This brings the sensitivity of the ear into the discussion. It is assumed that the causes for the curved shape of the sensitivity curve are manifold. The resonance of the sound conduction system is one important item. Fundamental laws on stimulation of the nerves, as, for example, Nernst's law, must be considered with the other factors. In this paper the physical characteristics of the craniolabyrinthine communications are added as a potential factor.

The left half of the sensitivity curve, (i. e., the lower tone limit to the optimum of the curve) could be partially explained as resulting from a gradual shift from isotonic to increasingly isometric conditions. The optimum is reached at the frequency where isometry is at the highest value. The lower tone limit is the frequency with the minimum of isometry compatible with cochlear function. The right half of the sensitivity curve can be explained by nerve-physiologic considerations.

#### IMPORTANCE OF PHYSIOLOGIC EXPERIMENTATION

In the past, the anatomic structures of the inner ear have been studied intensively. Each part of the cochlea has been diligently described and carefully measured. The function of each part, however, has not been studied satisfactorily. The students of hearing theories, therefore, have based their assumptions mostly on structural and not on functional considerations. This is unfortunately one sided and may be the reason that several auditory phenomena cannot be explained on the present anatomic basis.

The experiments described in this paper aim to show that certain factors can never be analyzed by anatomic technic but are demonstrable by physiologic methods.

More physiologic experimentation on the function of the structures of the inner ear seems to be a most desirable "Next Step in Auditory Research."

#### SUMMARY

The value of animal experimentation in the study of the function of the inner ear is discussed.

The acoustic reflex contraction of the intrinsic muscles of the middle ear is a simple, reliable indicator of cochlear function in animals and in man.

The conduction of the sound in the inner ear is studied. It is demonstrated that sound may reach the cochlea through the air of the middle ear, enter it through the round window and be conducted through the scala tympani (*"reversed sound conduction in the cochlea"*).

The intralabyrinthine fluid is an essential conductor of acoustic energy. Disturbance of the cochlear fluid is incompatible with good function. Direct conveyance of acoustic energy through the bone to the nerve ending is not possible. Regardless of the portal through which the sound enters the cochlea, the intralabyrinthine fluid is the *final common path* of sound conduction.

Bone-conducted sound can stimulate the cochlea even in the absence of the stapes. Bezold's teaching of osteotympanic bone conduction must be abandoned.

In a windowless cochlea the compressibility of the soft tissues is insufficient for good function.

The resistance of the craniolabyrinthine communications is a function of the frequency of the pressure changes. In the windowless cochlea the system of canals is incapable of acting as a "third cochlear window."

# SIMPLE MASTOIDECTOMY

A CRITICAL ANALYSIS OF ONE HUNDRED CONSECUTIVE CASES

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This study was undertaken for the purpose of determining various factors in the preoperative, operative and postoperative stages in the cases considered and evaluating them to aid in the conduct of treatment in similar cases in the future.

For this purpose, I have taken a series of 100 consecutive simple mastoidectomies which were all performed by me in the same hospital during the years 1935 and 1936. The operative technic and postoperative care were the same in all cases.

During the operative procedure, all tissue within the mastoid or connected with it which was infected or might later have become so by extension was exenterated.

To this end, the teachings of Meltzer<sup>1</sup> were found to be extremely useful. The position of the lateral sinus, once determined, gave much information concerning the relative size of groups of cells in various locations. I should emphasize the necessity of complete eradication of the zygomatic, the posterior angle, the parafacial and the parabyrinthine cells. I also concur in the opinion of Mosher<sup>2</sup>—and follow his practice—that removal of the mastoid tip is not routinely necessary unless it is fractured,<sup>7</sup> necrosed or perforated.

Full exposure of the tegmen and the plate of the lateral sinus was carried out in all cases, with free exposure of the dura of these regions, as advocated by Boies,<sup>3</sup> in doubtful conditions, when the operative findings in the mastoid did not seem sufficient to explain the clinical symptoms. No harmful effect has been observed in any of the cases in which such exposure was carried out.

Much care was taken in closing the wound, by through and through sutures, that there should be approximation of the edges of the periosteum, this being considered to aid in the formation of new bone in the cavity.

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Presented as a candidate's thesis to the American Laryngological, Rhinological and Otological Society, Inc., 1939.

1. Meltzer, P. E.: The Mastoid Cells: Their Arrangement in Relation to the Sigmoid Portion of the Lateral Sinus, *Arch. Otolaryng.* **19**:326 (March) 1934.

2. Mosher, H. P., in discussion on Boies.<sup>3</sup>

Of the 12 cases of recurrent mastoiditis to be reported, in 6 the previous operation had been done by myself with this technic, and in all 6 much new bone was found at the second operation.

Dressings were changed daily. Drains, which had been placed from the antrum through the lower angle of the wound, were loosened every three days and removed when drainage from the middle ear ceased, which occurred after an average of seven and six-tenths days.

The orthodox compression bandages were not used, the dressing consisting of a flannel square with four tapes, tied on the top of the

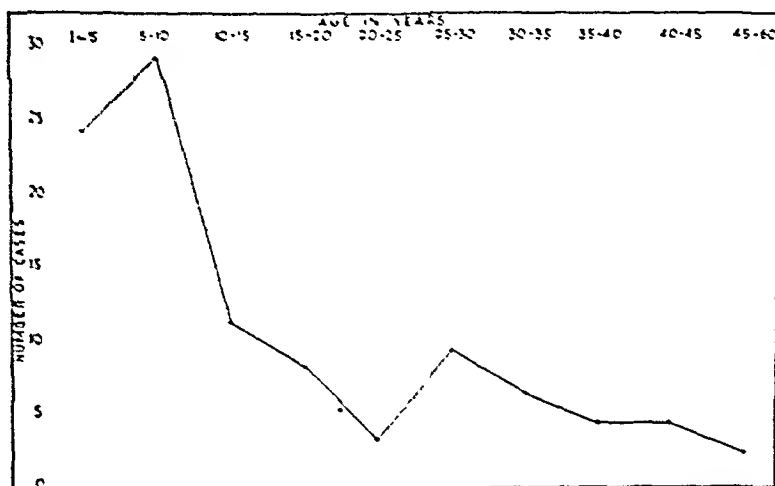


Chart 1.—Age incidence in 100 cases of mastoiditis

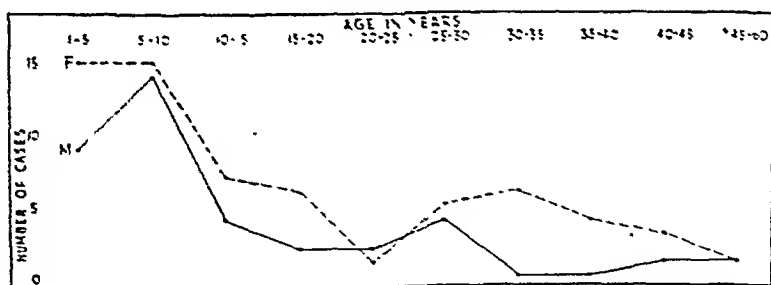


Chart 2.—Sex incidence in 100 cases of mastoiditis.

head. The use of this dressing has resulted in the development of much less edema of the tissues and allowed the saving of much time in applying dressings.

The patients ranged in age from 5 months to 58 years (chart 1); 24 were under 5 years of age and twenty-nine between 5 and 10 years of age, with a very sharp decline in the number in each succeeding five year period. The average age was somewhat younger than that reported by Boies.<sup>3</sup>

There were 67 females and 33 males in this series (chart 2). It is felt that the preponderance of females can be partially accounted for

3. Boies, L. R.: Extradural Inflammation: Study of Its Occurrence in Acute Surgical Mastoiditis, *Tr. Am. Acad. Ophth.* 41:150-162, 1936.

by the number of mothers who were thought to have contracted their infection from their children, as later reported.

Little variation was found in the lateralization of infection, the right side having been affected in 50 cases, the left side in 41 and both sides in 9.

Tabulation of the occupations of those affected (table 1) showed the largest group, numbering 39, to be of early school age, 5 to 10 years

TABLE 1.—*Occupation*

School child.....	39	Radio operator.....	2	Cabinet maker.....	1
Preschool child.....	30	Laborer.....	2	Painter.....	1
Housewife.....	20	Shoe worker.....	1	Farmer.....	1
Nurse.....	2	Mechanic.....	1		

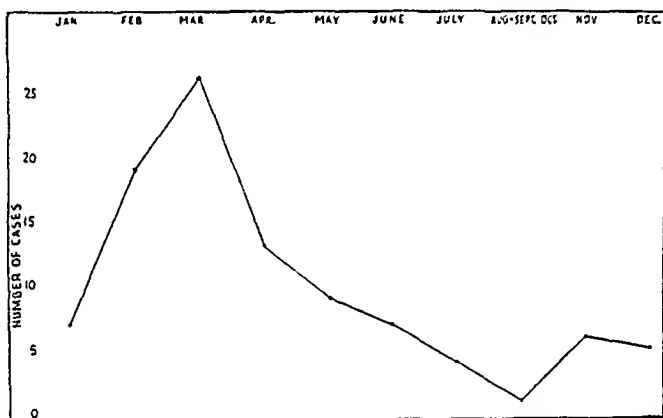


Chart 3.—Seasonal incidence of mastoiditis in the group of 100 cases.

old. The next largest group, numbering 30, was made up of children under 5 years of age. Housewives numbered 20, of whom 18 were mothers of children under 10 years of age who had personally attended their children during attacks of otitis media shortly before. In 3 instances, both mother and child were operated on within a few weeks.

The seasonal incidence, as shown by chart 3, which closely paralleled that reported by Kopetzky and Hadjopoulos,<sup>4</sup> was most significant. The incidence was greatest, 26, in March, dropping sharply to 13 in April, declining fairly rapidly to the low point in August, September and October, then rising slowly to 7 in January and from that point again rising sharply to the highest level.

4. Kopetzky, S. J., and Hadjopoulos, L. G.: Relationship of Upper Respiratory and Alimentary Tract Flora to Mastoid Infections, with Particular Reference to the Epidemiology of Mastoiditis, *Laryngoscope* 42:661-673 (Sept.) 1932.

This curve followed closely that of infections of the upper part of the respiratory tract in the community, and such an infection was found to be the immediate preceding illness in 51 of the 74 cases in which a definite history could be obtained (table 2).

Linked with the attacks preceded by infections of the upper part of the respiratory tract might be 5 preceded by acute tonsillitis, 3 by grip, 3 by acute sinusitis and 3 by pneumonia.

There seems to have been a definite etiologic relation between the prevailing disease of the upper part of the respiratory tract and the close association of the younger children with the mothers who attended them when ill, and many infections may have been transmitted from one to another.

TABLE 2.—*Preceding Illness*

Infection of the upper part of the respiratory tract.....	51
Acute tonsillitis....	5
Acute sinusitis.....	3
Pneumonia.....	3
Grip.....	3
Rubeola.....	7
Rubella.....	1
Varicella.....	1

TABLE 3.—*Associated Systemic Condition Present at Operation*

Pregnancy .....	3
Disease of the respiratory tract.....	9
Upper part of the respiratory tract.....	6
Bronchopneumonia .....	3
Acute sinusitis .....	1
Depressive psychosis .....	1

#### ASSOCIATED SYSTEMIC CONDITIONS

A number of associated systemic conditions present in these patients at the time of operation should be commented on (table 3).

1. *Pregnancy*.—One patient was operated on at the three month and 2 at the eight month stage, with no disturbance of pregnancy or of the postoperative course. Ether, without nitrogen monoxide induction, was used as the anesthetic, after consultation with the obstetric attendant.

2. *Disease of the Respiratory Tract*.—Five patients showed no ill effects but in 1 definite bronchopneumonia was found the day after operation. In 3 children operated on during the declining stage of bronchopneumonia, that disease was not exacerbated. Avertin with amylene hydrate was the anesthetic chosen in all cases of involvement of the respiratory tract.

3. *Acute Maxillary Sinusitis*.—One adult with active maxillary sinusitis, likewise operated on under anesthesia induced by avertin with amylene hydrate, suffered no ill effect, the sinus having been opened at the same time.

4. *Depressive Psychosis*.—In a woman of 35 in whom, during many years of chronic purulent otitis media, a depressive psychosis with suicidal tendency had developed, which condition she herself ascribed to the embarrassment of the foul discharge, operation and cessation of the discharge were followed by almost immediate recovery from the depressed state. There has been no recurrence in three years. Here, of course, the cause of the psychosis and the curative effect of operation cannot be positively demonstrated.

TABLE 4.—*Classification of Cases*

1. Cases of acute involvement.....	70
Those in which a history of previous operation or chronic otitis media was not given	
2. Cases of chronic involvement.....	15
Those in which history of chronic purulent otitis media was given; the shortest period in such history was six years; no patient presented a history or diagnostic findings indicating need of radical operation	
3. Cases of recurrence.....	12
4. Cases of revision.....	3
Those in which the patient was referred to my service because of threatening symptoms following a previous operation	

#### CLASSIFICATION OF CASES

For the purpose of this study the cases have been divided into four groups (table 4).

*Cases of Acute Involvement*.—In the first group observations were made on the following subjects: (1) effect of previous attacks of otitis media on the incidence of complicating conditions; (2) effect of paracentesis and of spontaneous rupture on the subsequent course of mastoiditis; (3) optimum time for operation, and (4) virulence of infection in exanthematous disease.

1. Effect of previous attacks of otitis media on the incidence of complicating conditions.

From 18 of the patients a history of previous otitis media with recovery was obtained, but in only 2 of these was any complicating condition observed. One, in whom the attack was preceded by varicella, had a subperiosteal and a perisinal abscess; the other, in whom it was preceded by infection of the upper part of the respiratory tract, had an epidural abscess.

2. Effect of paracentesis and of spontaneous rupture on the subsequent course of mastoiditis.

Paracentesis had been performed on 77 per cent of the tympanic membranes, and 23 per cent had ruptured spontaneously. While I am unable to demonstrate any definite differences in the course of the disease in these two groups, I believe that it is preferable to perform paracentesis to give the patient relief from pain and to promote drainage, since intramastoid pressure, as well as infection, is regarded as a cause of necrosis in mastoiditis.<sup>5</sup>

3. Optimum time for operation (table 5).

Three patients, all under 10 years of age, were operated on during the first week of otitis media, all having shown fulminating infection.

In 1, with operation on the sixth day, a perisinal abscess was found. In this patient pneumonia developed and death occurred on the fourth day. A second patient, with operation on the seventh day, showed a

TABLE 5.—*Incidence of Complicating Lesions*

Time of Operation	Number of Cases	Percentage of Complicating Lesions	
		Preoperative	Postoperative
First week.....	3	66	33
Second week.....	19	11	26
Third week.....	29	7	0
Fourth week and later.....	19	36	21

tense subperiosteal abscess, with a septic temperature, but recovered promptly without further complication. A third, with operation on the fifth day, because of an apparently septic course, showed no complication and recovered uneventfully.

Nineteen patients were operated on during the second week of otitis media, with complicating conditions appearing preoperatively in 11 per cent and developing after operation in 26 per cent. At operation 2 showed perisinal abscesses; postoperatively, erysipelas developed about the wound in 1 and thrombosis of the sigmoid sinus in another, while in 3 septicemic symptoms developed and blood cultures contained a nonhemolytic streptococcus.

The 29 patients operated on during the third week of otitis media showed the lowest incidence of complicating conditions, 7 per cent preoperatively and none postoperatively. At operation 1 presented mild labyrinthine symptoms and in another an epidural abscess was found.

All of those who were operated on after the third week were considered together, although the time of operation varied from the

5. Kopetzky, S. J.: *Otologic Surgery*, ed. 2, New York, Paul B. Hoeber, Inc., 1929, pp. 15-18.



twenty-third to the ninety-first day. This group included 19 patients and showed a high incidence of complicating conditions, preoperatively 36 per cent and postoperatively 21 per cent. At operation 3 patients presented labyrinthine symptoms, 2 had subperiosteal abscesses, and 2 had perisinal abscesses; while postoperatively, septicemia developed in 3 and bronchopneumonia in 1.

Too few patients were operated on during the first week of otitis media to permit drawing conclusions from their results, though it seems advisable not to operate so early in the absence of a definite complication.

About the third week is the optimum time for operation, because of coalescence and localization of infection, only conditions advancing rapidly toward complications warranting earlier operation. There is definitely greater danger of complicating lesions occurring, especially preoperatively, as the fourth week and later periods are reached, there being greater likelihood of the infection having reached vital visceral structures.

#### 4. Virulence of infections in exanthematous disease.

Of the 9 attacks preceded by acute exanthematous infection, rubeola preceded 7 and rubella and varicella 1 each. With 1 exception, all the patients came to operation with considerable elevation of temperature; all had extensive destruction in the mastoid area, and in 3 perisinal abscesses were found at operation. The circumstances may be construed to indicate, as shown by Harrell,<sup>6</sup> that the invasiveness and virulence of the hemolytic streptococcus are increased in contagious diseases, this organism having been found in 8 of the 9 patients.

*Cases of Chronic Involvement.*—The conditions previously classified as chronic were, it must be remembered, so called only because the acute mastoiditis occurred in patients who had had long-standing chronic purulent otitis media.

Contrary to my expectations there were few complicating conditions in this group. Only 2 patients showed preoperative symptoms of labyrinthine irritation; in none did any postoperative complication develop, and the average stay in the hospital was shorter than that with the acute conditions.

The work of Almour<sup>7</sup> leading to his recommendation that all eburnated bone need not be removed in radical mastoidectomies has been noted. While the operations here reported were performed for an acute condition, the same reasoning should apply so far as the eburnated bone is concerned.

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6. Harrell, V.: Hemolytic Streptococcus Mastoiditis, *Ann. Otol., Rhin. & Laryng.* 46:194-202 (March) 1937.

7. Almour, R.: The Practical Application of Wittmaack's Theory of Pneumatization, *Tr. Am. Acad. Ophth.* 37:315-332, 1932.

In these cases, acute mastoiditis was superimposed on chronic purulent otitis media. Simple mastoidectomy was performed. All eburnated bone was removed because of the difficulty in determining whether there was complete eburnation in a given area and the consequent possibility of isolated islands of infected cells and diploic tissue being present in the midst of the eburnated bone.

The opinion that this procedure should be followed has been voiced by Josephson,<sup>8</sup> and it has been supported by the observation in all my patients that the mastoid was not completely eburnated but that some cells and diploic tissue were present under and within the sclerotic bone.

Twelve of these patients have been completely cured. Three still have some discharge, with no other symptoms, and in these 3 there was probably more extended infection outside the mastoid process, and a radical operation may later be required.

I believe that if all these patients had had radical mastoidectomies without the removal of all eburnated bone with the enclosed infected cells and diploic tissue none of them would have been cured.

TABLE 6.—*Interval During Which Operation Was Repeated*

First six months.....	2
Second six months.....	3
Second year.....	3
Third year.....	3
Fourth year.....	1

I am inclined to think, because of these observations, that for many chronic suppurative conditions radical mastoidectomy may be avoided and that operation may safely be limited to simple mastoidectomy. If no infected cells or diploic tissue is found in the mastoid, the operation should be extended to radical mastoidectomy.

*Cases of Recurrence.*—In the group with recurrent mastoiditis, 12 in number, all patients had had at least one, and some several, previous simple mastoidectomies.

Their ages ranged from 3 years to 28. The interval since previous operation varied from two months to four years (table 6). Practically all attacks were preceded by infection of the upper part of the respiratory tract, with a short period of otitis media, averaging five and one half days, by the end of which time rapid infection and breaking down of the old wound had occurred.

The formation of new bone in these patients was carefully investigated at operation. In no patient whose previous operation had been done within a year could any new bone be demonstrated, but in

8. Josephson, E. M., in discussion on Almour.<sup>7</sup>

every one operated on previous to that period some new bone was formed, with the amount greater in the younger patients.

In all these patients the postoperative course was uneventful, and in no one was there any complicating condition.

*Cases of Revision.*—In the first patient on whom a revision operation was performed paralysis of the left facial nerve with weakness of the right facial nerve of ten days' duration had developed, following bilateral simple mastoidectomy two months previously. Hearing in both ears had also been lost completely. Records of the previous operation and after-course suggested labyrinthine disease at that time. Complete return of the function of the facial nerves followed within seven days after they were exposed bilaterally in their mastoid course. Much necrotic tissue was found in unremoved parafacial cells.

TABLE 7.—*Complicating Lesion*

A. Present at time of operation	
1. Irritative labyrinthitis.....	4
2. Perisinal abscess.....	5
3. Subperiosteal abscess.....	4
4. Epidural abscess.....	1
5. Paralabyrinthitis.....	1
6. Paralysis of the facial nerve.....	1
B. Developing after operation	
1. Irritative labyrinthitis.....	1
2. Septicemia.....	6
3. Bronchopneumonia.....	2
4. Metastatic abscess.....	3
5. Suppurative adenitis.....	2
6. Thrombosis of the sigmoid sinus.....	1
7. Erysipelas about the wound.....	1
8. Secondary hemorrhage from the wound.....	1

The second patient, 41 years old, had had simple mastoidectomy twenty-two days before. Because of persistent facial and orbital pain, a revision operation had been done seven days before, with no improvement in symptoms. Roentgenograms of the petrosa were normal, but at operation a sinus was located beneath the semicircular canals, from which several drops of foul pus was drained. Recovery, while slow and gradual, was complete.

In a third patient, whose wound had failed to heal after a simple mastoidectomy done two and one half years before, a revision operation disclosed infected residual zygomatic cells, and removal of these resulted in complete closure and uneventful recovery.

In all these revision operations it was felt that the cause of the complications mentioned was an incomplete primary operation.

#### COMPLICATING CONDITIONS

The complications in this series fall naturally into two groups (table 7).

1. *Complications Present at the Time of Operation.*—Of the 4 infections with labyrinthine symptoms, 3 occurred in patients with sclerotic mastoids who had had long-standing chronic purulent otitis media and 1 in a patient with an acute hemorrhagic condition of the mastoid. All vestibular symptoms disappeared within twenty-four to forty-eight hours after simple mastoidectomy. In the patient with the hemorrhagic mastoid secondary hemorrhage from the wound developed three days postoperatively.

The 5 perisinal abscesses were all in children, only 1 of whom had a history of previous otitis media.

Four subperiosteal abscesses occurred in children under 8 years of age.

One epidural abscess was found in a child of 5 months.

2. *Complications Developing After Operation.*—The single case in which irritative labyrinthitis occurred postoperatively was that of a child with a hemorrhagic mastoid, the symptoms being confined to transitory rotary nystagmus on the third postoperative day. In this patient septicemia and a metastatic abscess yielding a nonhemolytic streptococcus on culture also developed.

Although there were others whose symptoms suggested a septicemic condition,<sup>9</sup> only those with a positive blood culture were so classified. Of these there were 6.

#### COMMENTS

The following subjects will be commented on: (1) anesthesia, (2) organisms present, (3) characteristics of infections, (4) pain, (5) tenderness, (6) sepsis, (7) interpretation of roentgenograms, (8) observations on the blood, (9) mortality and (10) postoperative hearing.

1. *Anesthesia.*—The most satisfactory anesthesia was obtained with nitrogen monoxide and ether, which were used with 46 patients. Ether without nitrogen monoxide induction was used with 21 patients considered too young for satisfactory use of nitrogen monoxide. Avertin with amylene hydrate as a basic anesthetic, with anesthesia sustained by ether, was used with 33 patients, and, while satisfactory anesthesia was obtained, immediate postoperative convalescence was less rapid and satisfactory than in cases in which ether was used.

2. *Organisms Present* (table 8).—Cultures of material from the mastoids showed 54 per cent to contain *Streptococcus haemolyticus*, 9 per cent *Streptococcus nonhaemolyticus* and 12 per cent *Pneumococcus*, while 21 per cent yielded no growth. It was found that some of the

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9. Williams, A. W.: *Streptococci in Relation to Man in Health and Disease*, Baltimore, Williams & Wilkins Company, 1932, pp. 244-246.

culture mediums contained blood serum from a person later shown to be immune to *Str. haemolyticus*, and so many of the sterile cultures probably should have shown *Str. haemolyticus*.

3. *Characteristics of Infections*.—In general it may be said that in cases of streptococcic infection there were a more fulminating onset, a more active course of the disease as shown by elevations of temperature and of the leukocyte count and a greater proportion of complicating conditions.

In cases of pneumococcic infection there were a paucity of symptoms, a minimum of reactions of the temperature and blood and a much greater amount of destruction of bone than would have been expected from the symptoms observed.

4. *Pain*.—The absence of pain was not regarded as having negative significance, since many patients with extensive infection and destruction had little or no pain, as in the pneumococcic infections previously mentioned. However, pain, when present, was significant. Pain extending

TABLE 8.—*Organisms in Culture of Material from Mastoid*

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<i>Str. haemolyticus</i> .....	54
<i>Str. nonhaemolyticus</i> .....	9
<i>Pneumococcus</i> .....	12
<i>Staph. albus</i> .....	1
<i>Staph. aureus</i> .....	1
<i>Diphtheroid bacillus</i> .....	2
No growth.....	21

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over the mastoid proper and downward into the neck usually indicated an active infection of the tip. In the presence of temporal and parietal pain, operation almost always revealed necrosis of the tegmen or infection of the zygomatic cells. Sudden cessation of pain was noted in several patients in whom subperiosteal abscesses later developed.

5. *Tenderness*.—This was a much less helpful sign than pain, though many infections of the tip were diagnosed by tenderness over the tip and several perisinal abscesses by tenderness over the emissary vein.

6. *Sepsis*.—The absence of septic symptoms did not exclude destruction of bone, but every patient that presented septic symptoms did invariably show disease of the bone.

7. *Interpretation of Roentgenograms*.—While the clinical findings were given the most consideration in deciding whether to operate, roentgen findings were helpful,<sup>10</sup> although in many cases there were discrepancies between the clinical and operative findings and the interpre-

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10. MacMillan, A. S.: Personal communication to the author. Schillinger, R.: Roentgen Aspects of Mastoiditis, *Am. J. Roentgenol.* **39**:192-201 (Feb.) 1938.

tations of roentgenograms. This is not unusual, and, on the whole, interpretations of roentgenograms reached a high standard.<sup>11</sup>

8. *Observations on the Blood.*—Simple elevation of the leukocyte count did not have much significance, and no blood picture distinctive of mastoiditis was found.<sup>12</sup> Repeated differential counts according to the method of Schilling gave much help in prognosis, and the ratio between the total leukocyte count and the percentage of polymorphonuclear cells, especially when tabulated on McKernons' charts, as advocated by Kopetzky,<sup>5</sup> proved of real prognostic value (chart 4).

9. *Mortality.*—In this series 99 patients recovered and 1 died. The latter, a child of 6 who was admitted with a fulminating infection, showed a perisinal abscess at operation, on the sixth day of otitis media. On

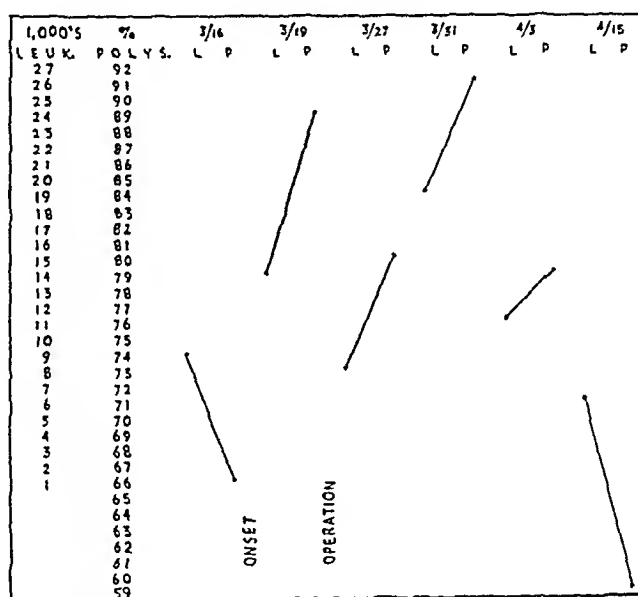


Chart 4.—Resistance chart for a case of sinus thrombosis in which recovery occurred.

the following day definite bronchopneumonia was evident, and death occurred on the fourth day. The pneumonia was regarded as the direct cause of death, but autopsy not having been permitted, factors related to the mastoid infection could not be excluded.

10. *Postoperative Hearing.*—Practically all the patients listed as having chronic infections now have a definite loss of hearing, as might be expected after long-continued chronic purulent otitis media, but in no case is it thought by the patient himself that this loss is greater than that

11. Brownell, D. H., and Hauser, J. J.: The Roentgenogram as an Aid in the Diagnosis of Surgical Mastoiditis, *Ann. Otol., Rhin. & Laryng.* **47**: 240-246 (March) 1938.

12. Rosenwasser, H., and Rosenthal, N.: The Blood Picture in Otitic Infections, *Arch. Otolaryng.* **14**:290-308 (Sept.) 1931.

existing before operation. If radical mastoidectomies had been done there probably would have been greater loss of hearing. In all but 3 of these patients discharge has ceased since operation.

Of the patients with acute mastoiditis, 4 are known to have some loss of hearing.

#### SUMMARY

An analytic report of 100 consecutive simple mastoidectomies, with 1 death, is presented.

Closure of the periosteum aided in the formation of new bone.

The use of noncompression bandages resulted in less postoperative edema of the tissues.

Mastoiditis was most frequent in those between 5 and 10 years of age. Many mothers of such children are believed to have been infected by them.

The frequency of mastoiditis was greatest in February and March and least in August, September and October.

Paracentesis was believed to be advisable.

The optimum time for operation was found to be about the third week of otitis media. Before that there is little localization, while after that, vital visceral structures are more frequently attacked.

In acute mastoiditis superimposed on chronic purulent otitis media, simple mastoidectomy with the removal of all eburnated bone was found to be sufficient.

In recurrent mastoiditis formation of new bone was not found in less than one year after the previous operation.

A revision mastoidectomy was indicated when sepsis with threatening symptoms was present or when faulty healing had occurred.

Cultures of material from the mastoid yielded in 54 per cent of cases a *Str. haemolyticus* and in 12 per cent a pneumococcus.

Streptococcic infection was associated with fulminating symptoms and numerous complicating lesions, while pneumococcic infection was practically symptomless but caused extensive destruction of bone.

# ATELIOSIS OF THE MANDIBULAR ARCH

CRITICAL COMMENT ON GLOSSEPTOSIS, THE SYNDROME  
OF PIERRE ROBIN

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NEW YORK

Considerable literature has accumulated dealing with observed cases of malformations resulting from arrest of development of the mandibular or the first branchial arch.

Study has been given to these conditions not only as they exist in the human species but also as they occur in the other amniota.

By far the most frequent conditions falling under this classification in man are micrognathia, cleft palate and harelip. These are examples of malformations existing in viable newborn infants.

Among the teratologic examples of the nonviable are cyclopia and agnathia. While the latter are interesting, they do not engage the attention of the clinician.

The condition of micrognathia is rather frequent among sheep and is called by shepherds "hog-jaw." Young lambs so afflicted cannot suckle or graze and are often destroyed for this reason.

As early as 1822 Geoffroy-Saint-Hilaire<sup>1</sup> described the case of a sheep which showed micrognathia, conjunction of the ears, deformity of the palate bone and fusion of the pterygoid processes of the sphenoid. He termed the condition *sphenocephalus*.

Taruffi<sup>2</sup> in 1891 attempted a classification of all the defects of the lower portion of the face as forms of a single major condition which he termed *hypoprosopoaplasia*. He then created subclassifications, such as *hypomicrognathia* (small lower jaw) and *hypoagnathia* (absence of the lower jaw), unilateral (also Maurice, 1861; Marc, 1892; Buerger, 1903, and others) and bilateral deformities and deformities of medium degree and of high degree.

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1. Geoffroy-Saint-Hilaire, E.: *Philosophie Anatomique*, Paris, J. B. Baillière, 1822, vol. 2, p. 97; cited by Ballantyne, J. W.: *Manual of Antenatal Pathology and Hygiene*, New York, William Wood & Company, 1905, vol. 2, p. 423.

2. Taruffi, C.: *Storia della teratologia*, Bologna, Regia tipografia, 1891, vol. 6, p. 389; cited by Eley and Farber.<sup>11</sup>



A most excellent description of the entire subject was given in 1922-1923 by Gladstone and Wakeley<sup>3</sup> under the title "Defective Development of the Mandibular Arch." They discussed the various possible developmental defects arising from absence or imperfect development of the central region of the craniofacial axis.

In 1929 Robin,<sup>4</sup> of Paris, published a monograph on glossoptosis. Robin was the first to call attention to the clinical problems arising as a result of micrognathia. He, however, placed particular emphasis on the problem created by the ptosed tongue and gave less attention to the developmental defect (micrognathia) which gives rise to glossoptosis. Fischer's<sup>5</sup> contribution on glossoptosis, appearing in the French medical literature in 1939, was based principally on Robin's monograph and referred to the "syndrome of Pierre Robin." Apparently, Robin was the first to describe glossoptosis and associated phenomena as a clinical entity. As recently as 1936 Turner<sup>6</sup> referred briefly to the syndrome in the fourth edition of his textbook.

Robin discussed micrognathia occurring in infants, the developmental anomaly characterized by retrusion of the mandible, which results in facial deformity and poor dental occlusion in later life. In micrognathia, ptosis of the tongue causes mechanical obstruction of the laryngeal portion of the pharynx. Robin stated that glossoptosis is extremely prevalent and that 3 of 4 children have this defect. However, only 1 of 4 adults past the age of 40 is glossoptotic; the other glossoptotic persons die prematurely, in most cases of illnesses which develop as a result of the decreased vital resistance and increased susceptibility to infection secondary to glossoptosis.

Examination and observation of a male infant<sup>7</sup> disclosed, among other developmental defects, the combination of micrognathia and glossoptosis to which Pierre Robin relates the many and varied manifestations of his syndrome. This infant had cleft of the soft and hard palate and the uvula, micrognathia and glossoptosis. At the birth there was normal vertex presentation, but delivery had to be made by the use of forceps. The general condition of the infant was poor, feedings were not taken well and respiration was labored. No cardiac nor pulmonary abnormalities were found on physical examination which could account for the

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3. Gladstone, R. J., and Wakeley, C. P. G.: Defective Development of the Mandibular Arch: The Etiology of Arrested Development and an Inquiry into the Question of the Inheritance of Congenital Defects, *J. Anat.* **57**:149, 1922-1923.

4. Robin, P.: *La glossoptose, un grave danger pour nos enfants*, Paris, Gaston Doin, 1929.

5. Fischer, H.: *La glossoptose: Le syndrome de Pierre Robin*, Paris, Vigot Frères, 1932.

6. Turner, A. L., and others: *Diseases of the Nose, Throat and Ear*, ed. 4, Baltimore, William Wood & Company, 1936.

7. Delivered at the Jewish Maternity Hospital, Jan. 11, 1937.

symptoms. Respiration became more rapid and irregular on January 16. Dyspnea of the obstructive laryngeal type was manifested by the marked retraction of the xyphoid cartilage and supraclavicular and intercostal spaces occurring with each inspiration (fig. 1, *A* and *B*). There were periods of respiratory movements during which no air apparently entered the lung. The free margin of the ptosed tongue filled in the palatine defect. Roentgenologic examination on January 16 indicated possible collapse of the upper and middle lobes of the right lung, and on January 20, central bronchopneumonia of the lower lobe of the left lung. The temperature rose to 103 F. Respiration was improved by elevating the lower jaw, and tubal feedings were successfully administered for a short time. Later, respiration again became rapid and labored; the temperature fluctuated between 99 and 104 F., and the infant died.<sup>8</sup> Permission for autopsy was refused.

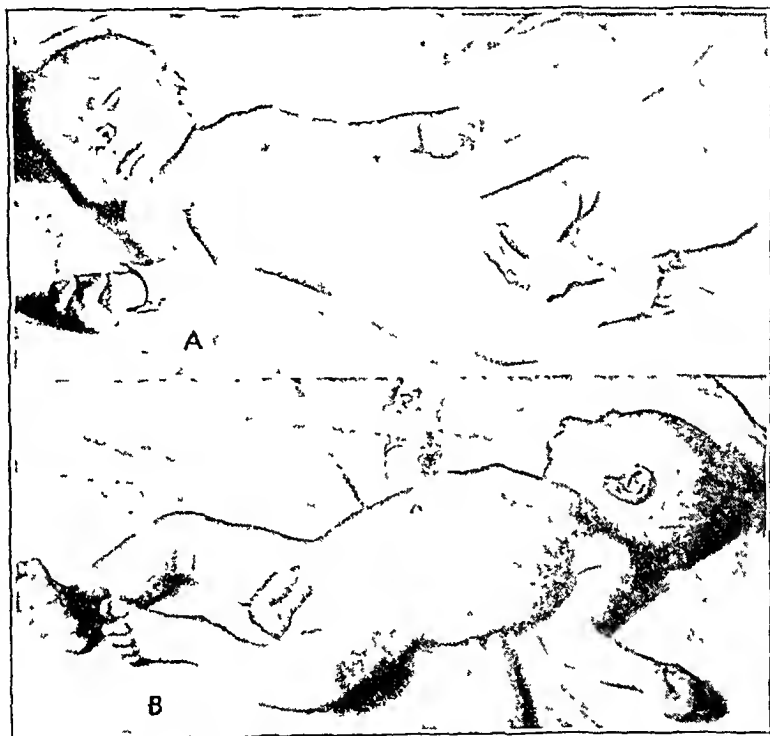


Fig. 1.—Photographs of the patient reported on. *A*, marked retraction of the xiphoid process characteristic of obstructive laryngeal dyspnea. *B*, micrognathism; retraction of the xiphoid process and the intercostal spaces is well marked.

#### MECHANISM

In this case there were two developmental defects, micrognathism and cleft palate, both manifestations of ateliosis of the mandibular arch. In this circumstance the malposition of the symphysis menti relaxes its attached ligaments, which results in backward displacement of the tongue, obstructing the pharynx and interfering with the free flow of air during respiration.

A variety of theories have been advanced to explain the mechanism of development of micrognathia. Normally, the developing mandibular arch

8. Jan. 27, 1937.

fuses in the midline, forming the symphysis menti. The ventral portion becomes the mandible and the dorsal portion the maxillary process, from which two shelves grow medially, fusing and forming the hard palate and the floor of the nose. Keibel and Mall<sup>9</sup> attributed micrognathia to simple arrest in this developmental process. They called attention to the fact that the fetal upper lip at the fifth month projects much further forward than the lower lip and suggested that an inhibitory process at a later period prevents outward growth of the lower portion which would overcome the disparity in projection between the upper and lower portions. Davis and Dunn<sup>10</sup> called attention to the fact that during uterine life the entire weight of the fetus rests on the vertex of the cranium and that during the same period the sternal region transmits a distinct pressure on the mandible. Since the latter develops and unites in the midline before the maxilla, pressure of sufficient magnitude could conceivably force the partly calcified mandible backward against the softer maxilla, with consequent production of deformity. The concomitant cleft palate in the case here reported, in the 4 cases reported by Eley and Farber,<sup>11</sup> in 2 of 3 cases reported by Lannelongue and Ménard<sup>12</sup> and in the case of Davis and Dunn lend weight to this theory. It is quite conceivable that sufficient pressure to retard the development of the mandible would likewise be able to prevent the fusion of the palate in the midline.

The development of glossoptosis is more readily explained than that of its antecedent, micrognathia. The genioglossi muscles are the principal means of drawing the tongue forward. Their insertion is at the symphysis menti, from which point traction on the tongue is maintained. In micrognathia, the backward displacement of the symphysis renders traction sufficient to prevent the tongue from dropping back an impossibility.

#### CAUSATION

Glossoptosis may be hereditary, congenital or acquired, the last being the most common according to Ivy.<sup>13</sup> The hereditary deformity can be

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9. Keibel, F. K. J., and Mall, F. P.: *Manual of Human Embryology*, Philadelphia, J. B. Lippincott Company, 1910.

10. Davis, A. D., and Dunn, R.: *Micrognathia: A Suggested Treatment for Correction in Early Infancy*, *Am. J. Dis. Child.* **45**:799 (April) 1933.

11. Eley, R. C., and Farber, S.: *Hyperplasia of the Mandible (Micrognathia) as a Cause of Cyanotic Attacks in the Newly Born: Report of Four Cases*, *Am. J. Dis. Child.* **39**:1167 (June) 1930.

12. Lannelongue, O. M., and Ménard, V.: *Affections congénitales*, Paris, Asselin & Houzeau, 1891, vol. 1, p. 423; cited by Eley and Farber.<sup>11</sup>

13. Ivy, R. H.: *Congenital and Acquired Defects and Deformities of Face and Jaws: Review of the Literature for 1936*, *Internat. Abstr. Surg.* **64**:433, 1937; in *Surg., Gynec. & Obst.*, May 1937.

traced through several generations. La Page<sup>14</sup> called attention to a case of this type in which the family history indicated that the previous deaths of 3 children were directly related to micrognathia with glossoptosis. Pfaff<sup>15</sup> noted hereditary transmission in 50 cases and traced the defect through several generations in some cases. On the other hand, Gladstone and Wakeley<sup>3</sup> in a study of 554 cases of harelip and cleft palate found the same condition in both parent and child in only 2 cases (0.35 per cent). They stated the belief that the condition is due to malnutrition of the embryo. The most frequent cause of congenital glossoptosis, according to Robin, is syphilis, because of the *Treponema pallidum*'s predilection for developing bone tissue. He gave no scientific evidence to corroborate this assertion. It is questionable whether, as a matter of fact, syphilis is a factor at all. Eley and Farber,<sup>11</sup> who observed 4 cases, did not mention the existence of syphilis in any of the infants, nor was there any evidence of the disease in their case in which autopsy was performed. Acquired glossoptosis may be caused by syphilis, by faulty location of teeth or, most commonly (Robin), by an improper position of the infant while nursing.

In his monograph, Robin traced the course of his syndrome from the development in the growing fetus to the end results in the mature person. The arrest in development of the mandible is regarded as the first step in a series of physiologic and anatomic disturbances which result in secondary somatic pathopoiesis of the entire organism, although all manifestations of the syndrome may not appear in every case. The severity of the symptoms is determined by the degree of glossoptosis, which in turn depends on how pronounced the micrognathism is.

Robin described a space, which he called the "confluent vital fonctionelle" (fig. 2), that includes all the upper respiratory-digestive passages, extending from the basilar vault to the glottis. The bony boundaries of this space are the jaw, the bones of the face, the cranium and the cervical spine. It therefore includes from above downward the nasal cavities, the nasopharynx, the oral pharynx and the laryngo-esophageal juncture. Robin abbreviated the term "confluent vital fonctionelle" to C. V. F., an abbreviation which will be used subsequently in this report, as it eliminates the difficulties of finding a suitable English equivalent.

The C. V. F. is not a fixed space but one the form and capacity of which change with alterations in the position of the bony structures comprising the boundaries. In man, the form and capacity of the

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14. La Page, C. P.: Micrognathia in the New-Born, *Lancet* 1:323, 1937.

15. Pfaff, cited by Brüning, H., and Schwalbe, E.: *Handbuch der allgemeinen Pathologie und der pathologischen Anatomie des Kindesalters*, Wiesbaden, J. F. Bergmann, 1913, vol. 2, p. 442.

16. Footnote deleted.

C. V. F. are particularly prone to change, as the upright position places the various structures within and bordering it in the relation of reciprocal support. Therefore, in man, a change in the position of but one of these structures may affect the positions of the other structures, eventuating in a profound disturbance of the C. V. F.

Robin developed the concept of his syndrome on this basis. He maintained that the backward displacement of the tongue in micrognathia obstructs air and food passing through the channels comprising the C. V. F., and, in addition, exerts pressure on the articulations, the nerves and the blood and lymph vessels in this region. Normal development and functioning of both contiguous and remote tissues is consequently impeded.

If the ptosed tongue is capable of exerting such pressure, his view may be accepted, for if arterial, venous and lymphatic circulation were impeded and the sympathetic and the last four cranial nerves, which

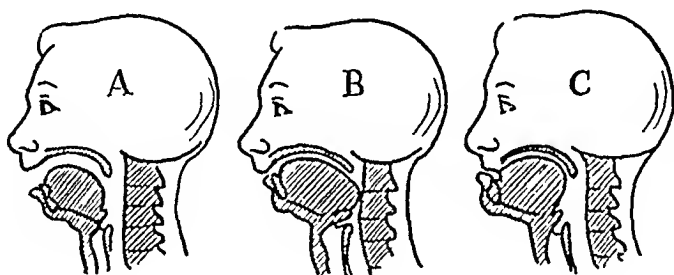


Fig. 2.—The “confluent vital fonctionelle” in the normal subject; position of the mandible and tongue during respiration (A) with the mouth open, (B) with the mouth closed and (C) with the jaw projected.

traverse this area, compressed, profound trophic disturbances and dysmorphism of the organism would be produced (fig. 3). The syllogism is far reaching if the premise is accepted.

#### DIAGNOSIS

Congenital or acquired glossoptosis is diagnosed in the following manner: The head of the infant, in the prone position, is held firmly by an assistant, and the examiner separates the lips with the fingers of one hand while slowly and gently pressing the chin backward with the other hand. If there is glossoptosis the lower gingival ridge recedes and is more or less set apart from the upper ridge. The degree of recession is in direct proportion to the severity of the deformity.

#### PROGNOSIS

The prognosis in glossoptosis depends on the cause of the micrognathism, the degree of mandibular recession, the age at which active treatment is instituted and the type of therapy employed.

The infant usually does not survive if the congenital mandibular deformity produces recession from the maxilla of 10 to 12 mm. or more (Robin). In later life, the micrognathic infant may develop compensatory prognathism as, after eruption of the temporary teeth, he learns that respiration is facilitated by locking the lower over the upper incisors. This prognathism should not be confused with the type seen in *macrognathia*.

Micrognathism is generally more conspicuous in patients in whom the condition had its onset during intrauterine life or before the age of

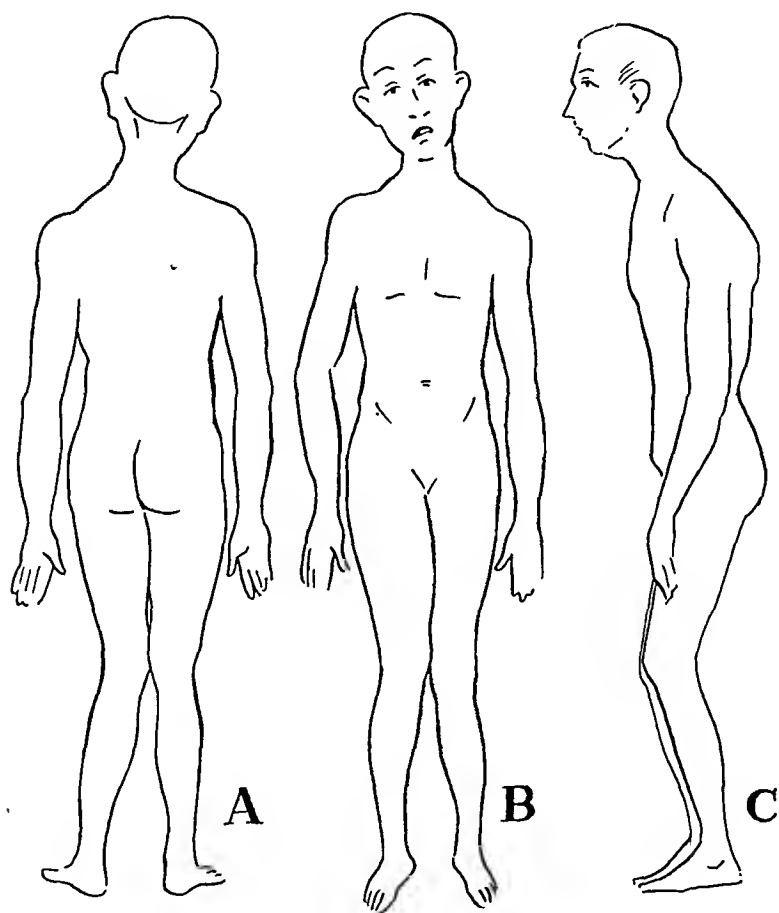


Fig. 3 (after Robin<sup>4</sup>).—Systemic manifestations of glossoptosis: (A) from the posterior aspect, protruding ears, kyphosis, scoliosis, lordosis, hands in pronation and genu valgum; (B) from the anterior aspect, strabismus, adenoids, carious teeth, erythrodermia, pigeon breast and flat feet, and (C) from the lateral aspect, dolichocephaly, harelip, rachitic rosary, abdominal ptosis, cryptorchidism and flexed knees. Glossoptotic subjects are slow in learning to talk and walk, and their mental development is retarded. They are subject to nightmares, tics, convulsions, chorea, headaches, meningeal affections, aprosexia, hyperhidrosis, sensitivity to cold, acrocyanosis, chilblains, varices, deviation of the nasal septum, sinusitis, pulmonary disease, mongolism, disorders of the thyroid and pituitary glands, aerophagy, dyspepsia, gastroenteritis, appendicitis, constipation and enuresis. Senile changes develop more rapidly than in the normal subject.

2 years. If the condition is not treated, all structures bounding the C. V. F. are maldeveloped, and there is consequent malnutrition and inadequate ventilation. According to Ullrich,<sup>17</sup> congenital glossoptosis is more serious than acquired glossoptosis. The postmortem studies in La Page's case indicated that cardiac dilatation was the principal cause of death.

#### TREATMENT

The treatment of micrognathia has been thoroughly discussed in the medical literature, especially the surgical treatment. Babcock<sup>18</sup> described a method by which the temporomandibular structure in front of the external auditory canal is disarticulated, the mandibular heads forced anteriorly and the gaps filled with costal cartilage. Eley and Farber<sup>11</sup> used a splint of their own devising to hold the jaw forward and reported successful results from this treatment. Hensel<sup>19</sup> performed osteotomy of the ascending rami and grafted bone into the symphysis menti.

The objective in all corrective measures for glossoptosis itself is obtaining a favorable position of the head and jaw. When the head is bent forward, the backward movement of the jaw tends to contract the C. V. F.; conversely, when the head is extended, the C. V. F. is expanded and respiration facilitated (fig. 4). Consequently, the position of the jaw is of fundamental importance.

In advanced stages, suturing the tongue to the lower lip seems to be the indicated measure. However, the danger of infection with the ever present oral bacteria renders the measure objectionable, and it is almost invariably followed by bronchopneumonia. La Page found that the infant nursed and breathed better when in a position approaching complete ventral decubitus with the neck extended; he used the Eley-Farber splints with unsatisfactory results. Mouth breathing is a feature of glossoptotic persons and frequently leads to tonsillectomy and adenoidectomy. Unless the condition of the tonsils and adenoids indicates that they should be removed, there is no more reason for their surgical removal than there is in the normal person. In severe cases tracheotomy may be required.

Davis and Dunn, noting that the young of lower animals reach outward and upward to nurse, stated the belief that glossoptotic infants should be encouraged to nurse in a similar manner. In the case of bottle-fed infants an appliance can be devised so that they stretch their necks while feeding.

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17. Ullrich, G.: Glossoptosis bei Mikrognathie, *Deutsche med. Wchnschr.* **61**: 1033, 1935.

18. Babcock, W.: The Surgical Treatment of Certain Deformities of the Jaw Associated with Malocclusion of the Teeth, *J. A. M. A.* **53**:833 (Sept. 11) 1909.

19. Hensel, G. C.: The Surgical Correction of Mandibular Protraction, Retraction and Fractures of Ascending Rami, *Surgery* **2**:92, 1937.

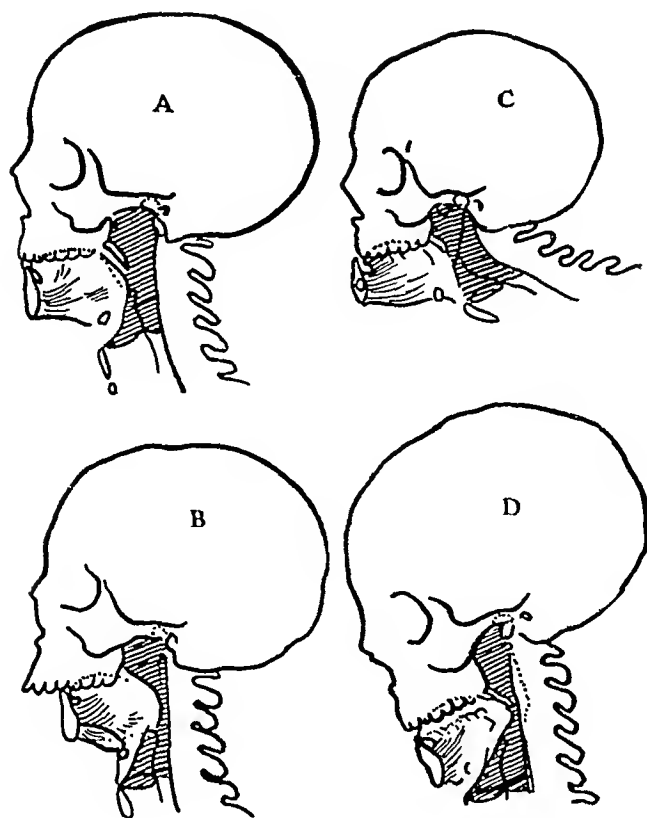


Fig. 4 (after Robin <sup>4</sup>).—Variations in the capacity of the “confluent vital fonctionelle”: (A) volume in the normal subject; (B) decreased volume in glossoptosis with the mouth closed, the posterior position of the mandible dropping the tongue toward the spinal column; (C) volume increased in glossoptosis by extension of the head; (D) volume decreased in glossoptosis by flexion of the head.

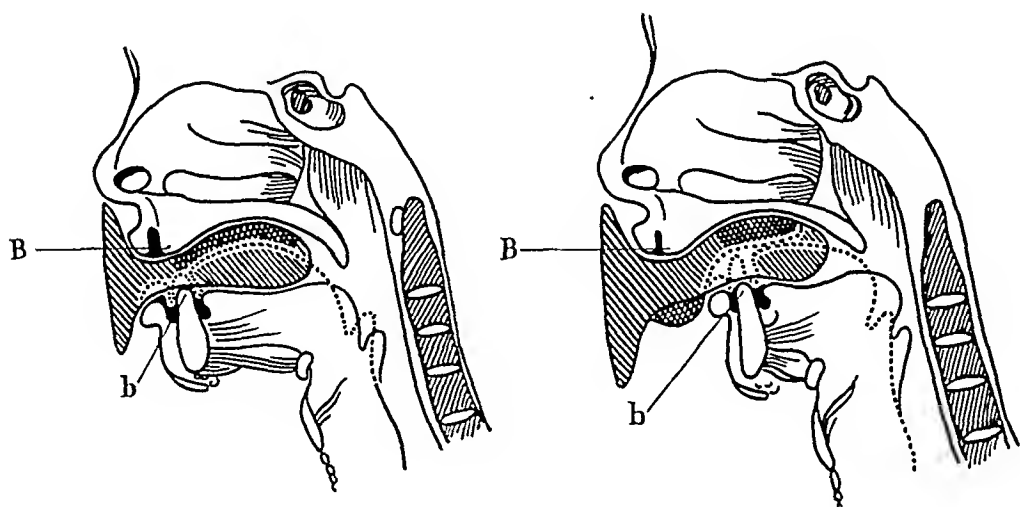


Fig. 5 (modified from Robin <sup>4</sup>).—Left, the mechanical factor: the nipple emptied by compression between B and b. Right, nursing with mandibular atresia; note the incomplete compression of the nipple due to functional and anatomic changes in the tongue and disturbance in the relation between B and b. Hatching indicates the nipple full of milk; crosshatching, the nipple emptied.



Robin endorsed this type of feeding, which he referred to as orthostatic nursing, and recommended in addition the divided feeding, i. e., interruption of nursing after six swallows for the purpose of rest. He stated that with breast-fed infants, the weight of the breast rests heavily on the infant's chin during nursing and may thus cause slight recession of the mandible, which becomes progressively more pronounced, with glossoptosis as an ultimate result. Robin stated the belief that an improper position of the infant while nursing is the most common cause of acquired glossoptosis and leads to the same difficulties as are caused by congenital glossoptosis (fig. 5).

According to Robin,

Decrease in the lower maxillary space results primarily in glossoptosis, particularly in a dropping backward of the floor of the mouth and the base of the tongue, the impingement of which against the spinal column closes the epiglottis, thus bringing about obstruction of the lower part of the respiratory tract and compressing the neurovascular clusters of the functional vital confluent. So, on the one hand, glossoptotic persons are forced to breathe through their mouths, and, on the other hand, they are subject to nutritional disturbances. Not only do they experience difficulties of mastication, digestion and respiration, but the compressions and ptoses bring about frequent and serious disturbance of function in all the vital organs controlled by the sympathetic and central nervous system, as well as skeletal deformities. These considerations clearly indicate the pathogenic importance of glossoptosis and the necessity of treating it as soon as it appears.

#### COMMENT

In a short critical review, it would be impossible to discuss all points elaborated by Robin. A brief discussion of the more outstanding facts and theories, however, suffices to demonstrate that the disorders that may follow glossoptosis due to micrognathia, for which there are relatively simple anatomic and physiologic explanations, have been expanded, without scientific basis, into a complicated, intricate, all-inclusive syndrome by resorting to gross hypothesizing, which is stated in terms of absolute fact.

It hardly seems likely that the many and varied morbid changes described by Robin could have their origin in glossoptosis caused by micrognathia. In the majority of cases of glossoptosis, the pressure on pharyngeal structures or the impediment to the free passage of food and air is scarcely sufficient to bring about changes which affect the development of the entire organism so profoundly.

A review of Robin's monograph leads to doubt concerning the various morbid changes which he ascribes to glossoptosis. Moreover, it may well be questioned whether such changes could all be caused by micrognathia, and it seems more plausible that the existence of such a large number of marked manifestations can only be based on a more profound genetic anomaly.

The existence of some underlying genetic fault seems plausible from observed coexisting developmental errors. Besides the frequently associated cleft palate, the following conditions are observed: ankylosis of the temporomandibular joints (Taruffi), ankylosis of other joints (Perthes) and congenital clubfoot, scoliosis and muscular weakness (Lannelongue and Ménard).

In this connection Gladstone and Wakeley<sup>3</sup> concluded:

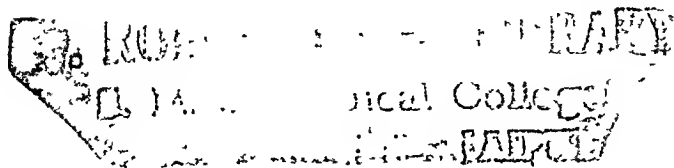
We believe that the defects in growth of the face and lower jaw are usually associated etiologically with defective development of the brain; for instance cyclops with defective growth of the fore-brain; otocephaly and agnathia with maldevelopment of the hind-brain.

If this conclusion is accepted, a partial explanation, at least, is available for some of the many phases of the syndrome expounded by Robin.

#### SUMMARY

An infant with congenital micrognathia, glossoptosis, cleft palate and cleft uvula is described and the condition discussed, with a review of the literature and a critical appraisal of the "Pierre Robin syndrome."

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# BORDERLINE ALLERGY

## ITS RELATION TO HYPERPLASTIC DISEASE OF THE RESPIRATORY TRACT

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AND

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The difficulties in properly evaluating the symptoms and pathologic picture of hyperplastic disease of the respiratory tract have resulted in a regimentation which falsely groups the borderline cases in classifications which belie their allergic nature. Physicians have been taught to recognize allergy only by the classic symptoms of obstruction and watery discharge and by the pathologic findings of eosinophilia, edema or extreme grades of hyperplasia. They have entirely forgotten that in the nose, as everywhere else in the body, different symptom complexes exist which are dependent on the degree of pathologic change or the constitutional makeup of the individual at a particular time. Rackemann<sup>1</sup> aptly voiced this in the following comment:

. . . There are many gradations between those not sensitive at all, and those extremely sensitive. In the middle ground, there are people who are slightly sensitive to one thing or, usually, . . . to a variety of things. I think we shall get farther if we regard the allergic group as simply a variation of the normal group.

As stated by Vaughan,<sup>2</sup> the difference between the allergic and the nonallergic is not so much qualitative as quantitative, i. e., a pathologic exaggeration of a normal physiologic response, and the same assertion holds for manifest and for borderline allergic patients. The latter are those who do not present the classic symptoms and pathologic picture of manifest allergy but present positive reactions to concentrated protein allergens and have or have had other mild allergic manifestations or come from allergic families.

Vaughan coined the term "minor allergy"<sup>2</sup> for such conditions as migraine, eczema and hyperesthetic rhinitis. Of a community of 508

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1. Rackemann, F. M., in discussion on Vaughan,<sup>2</sup> p. 211.

2. Vaughan, W. T.: Minor Allergy: Its Distribution, Clinical Aspects and Significance, *J. Allergy* 5:184, 1934.

persons, he found that about 60 per cent suffered from minor or major allergy. This figure is generally accepted as applicable in most communities. However, if a careful study over years is made of the respiratory difficulties of so-called nonallergic members of the families involved, it will be noted that they are chronic sufferers from colds, intermittent nasal obstruction, pharyngitis, recurrent laryngitis and conduction deafness. It will be found further that a great percentage of them become manifestly allergic at some time. Neither of Vaughan's terms suffices to describe the clinical or pathologic picture which they present, and so we propose that they be classified as borderline allergic patients, since their respiratory mucosa definitely reveals pathologic changes.

Careful observation of a large group of such patients over fifteen years has convinced us that those who initially presented symptoms and findings of so-called intumescent, hypertrophic or hyperplastic rhinosinusitis, chronic lymphoid pharyngitis, recurrent laryngitis, pachylaryngitis, nodes and some types of chronic tubal tympanitis become at some time frankly allergic. The difficulties in properly classifying them have been due to the false premise that allergic patients must present the classic symptoms of allergy. The heavy pollen season of 1939 in the Middle West has particularly convinced us of the truth of our early observations. In over 200 patients treated by us for years for hyperplastic conditions of the nose, throat and ears or for frequent colds and nasal suppuration, classic symptoms of hay fever have for the first time developed.

A great deal has been written<sup>3</sup> concerning the character of the formed elements of the mucosal discharge in allergic patients, particularly the eosinophils and the polymorphonuclear leukocytes, as a means of differentiating the allergic from the nonallergic patients. Admittedly about 90 per cent of the manifest allergic patients reveal eosinophilia, but this finding is nonexistent in most patients during the formative period of the allergic condition (fig. 1). The predominating cells are the lymphocytes, plasma cells, histiocytes, polymorphonuclear leukocytes and other wandering macrophages. We therefore feel that the picture of the mucosal discharge is wanting as a test for the differentiation of borderline allergy.

The color and texture of the nasal, pharyngeal or laryngeal tissues are of little diagnostic significance, except in areas exposed to the air current

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3. Hansel, F. K.: *Allergy of the Nose and Paranasal Sinuses*, St. Louis, C. V. Mosby Company, 1936. Cowie, D. M., and Jimenez, B.: *Cytologic Examination of Nasal Smears of Sensitized and Nonsensitized Persons with Nasal Symptoms, with Special Reference to Eosinophil Counts and to Simultaneous Blood Counts*, Arch. Int. Med. 57:85 (Jan.) 1936.

or to the drip of the exudates. Ordinarily some hyperplasia is noted throughout the mucous membrane but especially along the anterior tip and pendulous portions of the middle turbinate, where the tissues appear rather transparent, along the lateral pharyngeal walls, where a bar

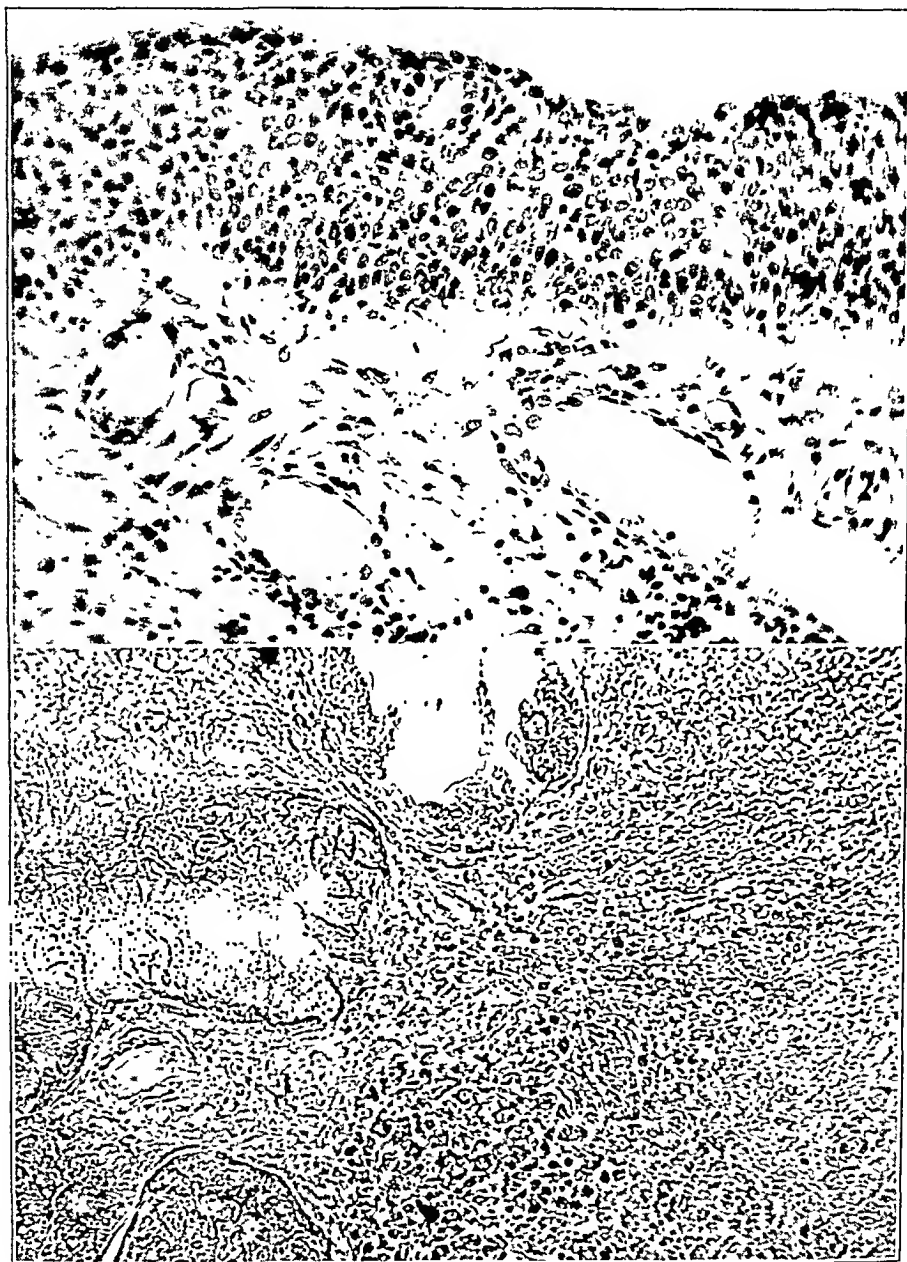


Fig. 1.—Above, tissue from a patient with borderline allergic rhinitis, revealing epithelial hyperplasia, thickening of the basement membrane, numerical increase in all cellular elements, increase in glandular activity and a normal number of eosinophils (hematoxylin and eosin stain;  $\times 246$ ). Below, section of same tissue as shown above but stained by the oxydase technic for the identification of leukocytes, including eosinophils. Note the absence of this group of cells ( $\times 492$ ).

formation is noted, and on the vocal cords, where definite discrete or diffuse thickening takes place. Early in the course of borderline allergy, even these findings may be absent.

The gross pathologic changes which occur in the respiratory mucosa are primarily the result of edema and fibrosis. Between attacks, however, the mucosa may appear normal. The degree of pallor depends on the fluid content of the tissues. It is fair to say that when edema and pallor exist an active allergen is responsible and is coming in contact with the tissues in amounts which are able to cause these changes. It must be remembered, however, that small amounts of allergen are able to cause a gradual thickening of these tissues without an intervening period of acute edema. Also, the color of the tissues in this instance is that associated with hyperemia. The changes correspond with the results of cytologic examination, i. e., during an acute attack (fig. 2), there are pallor, edema and eosinophilia, but in low grade, minor involvement (fig. 1), hyperemia and thickening, with only a few or a normal number of eosinophils in the smear.

Histologically, the tissues reveal the presence of a hyperplastic process (fig. 1). All connective tissue elements are increased, but the classic edema of the tunica propria is missing except to a slight degree. The basement membrane in such cases is frequently greatly thickened, out of proportion to the changes noted in other areas. The cellular elements are preponderantly round cells, histiocytes, fibroblasts, plasma cells and neutrophilic leukocytes. Though eosinophils are present, they occur only in normal numbers. Such elements as subepithelial abscesses and cysts are missing. This type of tissue frequently shows changes in bone, tending to make for a more compact bony structure. Numerous osteoblasts and osteoclasts are noted along the bony surfaces, where new bone can be seen. The blood vessels are much increased in number and show a high degree of periarteritis. The glandular elements appear about normal in number but actively engaged, with a greater preponderance of mucous glands. The tissues reveal without exception occasional organisms usually present in the respiratory flora, such as pneumococci, Friedländer's bacillus, *Micrococcus catarrhalis*, streptococci, *Bacillus influenzae* and staphylococci. In such patients a study of the exudates, particularly of nasal smears, gives little information on the allergic character of the condition.

The diagnosis of borderline allergy is made by the finding of gross hyperplastic changes in a person with a history of allergy or in whose family there is a history of allergy. In addition to manifest symptoms, one must be suspicious of a history of frequent colds, intermittent nasal obstruction with postnasal drip, chronic lymphoid pharyngitis, pachy-

laryngitis, singers' nodes and papillomas, chronic purulent sinusitis which does not yield readily to routine treatment and tubal tympanic deafness. The same symptom complexes must be carefully looked for in the immediate family of the suspected borderline allergic patient.

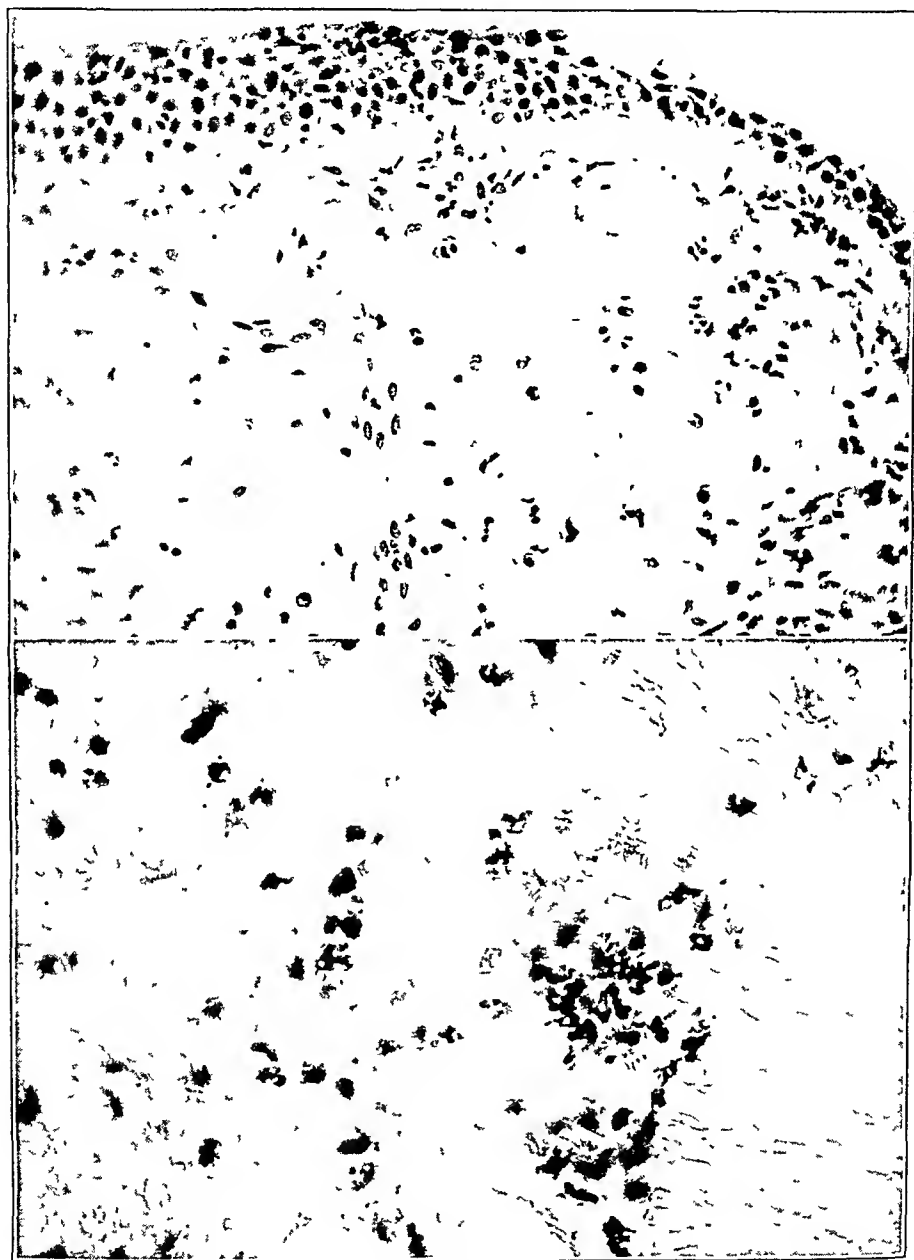


Fig. 2.—Above, tissue from a patient with active allergic rhinitis (hay fever). The appearance is similar to that in figure 1, except for the increase in edema in the substantia propria and the presence of numerous eosinophils (hematoxylin and eosin stain;  $\times 246$ ). Below, section of same tissue as above but stained by the oxydase techniqn for the identification of leukocytes. Note the great number of these cellular elements ( $\times 492$ ).

Because of the little help ordinarily afforded by precise laboratory data, the history becomes all important in making a diagnosis. A typical family history demonstrating this fact is as follows:

H. G., aged 45, has been treated for years for "chronic catarrhal conjunctivitis." We have seen him numerous times in the past fifteen years because of frequent colds, each followed by residual pansinusitis lasting three to four weeks. The nasal tissues were thickened and hyperemic even between colds, and a mucoid secretion was present more or less constantly in the nasopharynx. On many occasions we also treated both his children for numerous colds. In fact, the children definitely presented a pediatric problem because of this condition. The patient is unable to remember much about his parents, since they died young, and he has no other living relatives except one brother, who is apparently normal. At the age of 8, i. e., six years ago, severe autumnal hay fever developed in his son, which, however, disappeared at the age of 13. He has been free of hay fever for two years. In the daughter, who is two years younger, i. e., 12, severe autumnal hay fever developed during the present (1939) season. Though for the past ten years we have suspected an allergic taint in the parent, the repeated lack of laboratory evidence of eosinophilia, either in the blood or in smears, together with the absence of a family history of manifest allergy, had made us hesitant about classifying this condition as allergic. The appearance of hay fever in the elder child six years ago, however, clarified the situation, so that we were able to complete an allergic survey and more intelligently treat the entire family.

It is not our purpose to present the condition as a new disease, since obviously the borderline type differs from the manifest type only in the degree of severity of the condition at the time of examination. We must realize that the symptoms and findings are merely those which occur in one condition, i. e., hyperplastic disease of the respiratory tract, but for the sake of clarity we shall discuss each as a separate entity. The symptom complexes which we suggest be recognized as possibly allergic are as follows: (a) chronic intermittent nasal obstruction with postnasal drip; (b) chronic lymphoid pharyngitis; (c) frequent colds; (d) recurrent acute laryngitis, pachydermia laryngis, singers' nodes and papillomas; (e) chronic purulent discharge from the nose in children, and (f) tubal-tympanic catarrh.

## SYMPTOM COMPLEXES

### CHRONIC INTERMITTENT NASAL OBSTRUCTION WITH POSTNASAL DRIP

Chronic, intermittent nasal obstruction with postnasal drip is the result of thickening and irritation of the nasal mucosa. In such cases, intermittent obstruction is present on one side of the nose at a time, changing with the position of the head and affected by weather, alcohol, emotions and irritating vapors but particularly by pollens and other protein dusts. Many patients suffer from headaches, and the majority have associated endocrine hypofunction. Concurrent with these symptoms is an annoying postnasal drip and an accumulation,



particularly on arising, this being the night's secretion from the sinuses. This may be the symptom that brings the patient to the doctor. Short attacks of sneezing may be present, especially on arising, but not the persistent sneezing of hyperesthetic patients. It must be differentiated from purulent sinusitis, though a purulent infection may also be present, particularly in children. In such cases, the nasal smear reveals nothing unusual. Lavage of the nose or sinuses reveals a perfectly clear discharge, with a  $p_H$  close to 7.0 and high in protein, so that it appears exceedingly foamy on being shaken in a test tube. The cases described in many textbooks as those of intumescent rhinitis or hypertrophic rhinitis belong to this group. These conditions in time may become severe enough to present the classic symptoms of hyperesthetic rhinitis. It is our feeling that the difference is merely one of degree, the earlier stage being a quiescent state in a person with an allergic tendency, ready when stimulated by the proper allergens to develop into the extreme state of vasomotor imbalance and hyperesthesia manifested in cases of frank allergic rhinitis. It must be remembered that allergic conditions are exudative and that when even a mild allergy exists some exudation occurs. It is this type of patient, so common in rhinologic practice, that has during the present pollen season turned up with frank symptoms and signs of hay fever. This is the type of patient also who frequently suffers from virus colds, chronic lymphoid pharyngitis, laryngeal conditions and tubal tympanic catarrh. Pathologically such patients present grossly and histologically various degrees of hyperplasia and represent the uppermost bounds of a general hyperplastic change noted throughout the respiratory mucosa.

#### CHRONIC LYMPHOID PHARYNGITIS

Chronic lymphoid pharyngitis is a natural sequence to the condition just described. In the adult, it is characterized by a pharyngeal cough made worse by smoking, a postnasal drip with morning accumulations which have to be coughed up and at times pharyngeal pain due to the bathing of the tissues in secretions all night, which tends to disappear as the day wears on. This group of symptoms is more frequently complained of by adult patients than any other nasal or pharyngeal symptom complex, and yet it is one for which probably the least is done. Obviously, the postnasal drip is due to either a purulent or a non-purulent process in the posterior sinusal group of cells, which may be differentiated by washing out the sinuses and examining the washings. When they fail to reveal pus, one should suspect an allergic condition, particularly when the tissues in the area show hyperplastic changes. Grossly, examination of the pharynx and postnasal area in such patients reveals hypertrophy of the posterior tips of the lower turbinates, the so-called "mulberry type" of turbinate, with postnasal atrophy of the mucosa of the lateral borders of the posterior choanae

and the mucosa of the rostrum of the sphenoid sinus. There is usually decided hyperplasia of the lateral pharyngeal bar and occasionally some hyperplasia of the mucosa of the posterior wall of the nasopharynx. These are the areas over which the exudate drips from the posterior sinuses, and the changes are apparently due to the enzymes in these exudates, or they may be due directly to offending allergens. In young children of allergic taint, particularly the tonsillectomized ones, the lymphoid hyperplasia becomes marked but is seen to involve the posterior wall of the pharynx rather than the lateral wall and accounts for the rapid regrowth of adenoids in many of them. One should be suspicious of allergy in every child presenting the so-called adenoid diathesis. Piness and Miller<sup>4</sup> have ably summed up their experiences in the following observations:

. . . a regrowth of lymphoid tissue in the tonsillar fossae after tonsillectomy is as characteristic of allergy as the original enlarged tonsils, whose size alone so often seems to be the only indication which led to their removal. Lymphoid hyperplasia is one of the distinctive features of allergy.

#### FREQUENT COLDS

Of a series of over 1,200 patients whom we have attempted to immunize to the common cold because of their susceptibility to this disease, over 80 per cent have proved allergic or of an allergic family. Other observers have noted the incidence of colds in allergic persons.<sup>5</sup>

There have been attempts by others to differentiate the so-called allergic from the nonallergic cold.<sup>5b, c</sup> This has only resulted in confusion of nomenclature. Colds occur in allergic persons, but there is no scientific evidence that allergy causes the common cold. The numerous workers in the field of acute diseases of the upper part of the respiratory tract<sup>6</sup> have definitely described and identified the common cold and its

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4. Piness, G., and Miller, H.: Allergy: A Nonsurgical Disease of the Nose and Throat, *J. A. M. A.* **85**:339 (Aug. 1) 1925; Allergy of the Upper Respiratory Tract in Infancy and Childhood. *ibid.* **113**:734 (Aug. 26) 1939.

5. (a) Hansel, F. K.: Further Observations on the Cytology of the Nasal Secretions in Allergy, read at the meeting of the Association for the Study of Allergy, San Francisco, Calif., June 12-13, 1938; abstracted, *J. Allergy* **10**:251, 1939. (b) Cohen, M. B., and Rudolph, J. A.: Allergic and Infectious Conditions of the Upper Respiratory Tract in Children: Differential Diagnosis, *J. A. M. A.* **97**:980-982 (Oct. 3) 1931. (c) Clein, N. M.: Allergy as the Cause of Frequent Colds and Chronic Coughs in Children, *Northwest Med.* **35**:347, 1936.

6. Foster, G. B., Jr.: The Etiology of Common Colds, *J. A. M. A.* **66**:1180 (April 15) 1916. Dochez, A. R.; Mills, K. C., and Kneeland, Y., Jr.: Studies on the Common Cold: Cultivation of Virus in Tissue Medium, *J. Exper. Med.* **63**:559, 1936. Shibley, G. S.; Mills, K. C., and Dochez, A. R.: Studies on the Etiology of the Common Cold, *J. A. M. A.* **95**:1553 (Nov. 22) 1930. Kruse, W.: Die Erreger von Husten und Schnupfen, *München. med. Wchnschr.* **61**:1547, 1914.

cause. The term allergic cold, appended to a train of symptoms characterized by sudden attacks of sneezing, watery discharge, nasal obstruction and eosinophilia, which is merely an acute manifestation of allergic rhinitis, is a misnomer and should be dropped from the vocabulary.

The most important accidental factor in infections is trauma. Immunologically speaking, in an allergic response, the union of antigen and antibody in the cells results in injury and release from the cell of some preformed histamine-like material. So, the stage is set in the nasal mucosa of the allergic patient through the continual bombardment by foreign proteins, causing injury by the release of histamine-like materials and the production of a locus minoris resistentiae. It may be said that physically normal persons who exhibit a tendency to frequent colds suffer from an allergic state, and, vice versa, the allergic patient *suffers from frequent colds*. *It is normal for persons to get from one to three colds during a year*. However, the sufferer from colds seeking help from the physician is likely to get from six to ten colds yearly, each cold occurring during one of the numerous cycles of virus colds which occur almost monthly throughout the year. Not infrequently, and particularly in children, these colds are so numerous that the patient continually has suppurative pansinusitis, which represents the residuum carried over from one cold to another. Such patients, it must be remembered, are physically normal, but if their noses are examined hyperplastic changes are found. Our belief that patients with frequent colds are allergic rests on the further evidence obtained by a survey of foreign proteins. Bacterial examination of material from the tissues of these patients reveals without exception, between attacks of colds, the organisms so frequently recognized as secondary invaders, namely, the pneumococcus, Friedländer's bacillus, *M. catarrhalis*, streptococci and *B. influenzae*, ready at the optimum time to overgrow. The optimum time apparently occurs after additional injury by the cold virus. These patients further show a decided cutaneous reaction to solutions of attenuated cold virus. Dochez and his colleagues<sup>7</sup> made the interesting observation that colds following the inoculation of virus in chimpanzees resulted in striking changes in the bacterial flora of the nose and throat. The pneumococci and influenza bacilli became much more numerous and appeared in the nasal passages which had previously been free of them as shown by culture. Most allergists<sup>8</sup> have noted that the hay fever sufferer who has numerous colds, after several years of treatment, even though he has not been desensitized to colds, exhibits only the number

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7. Dochez, A. R.; Mills, K. G., and Kneeland, Y., Jr.: Filtrable Virus Infection of the Upper Respiratory Tract, *J. A. M. A.* **110**:177 (Jan. 15) 1938.

8. Sternberg, L.: The Effect of Pollen Injections on the Common Cold in Hay Fever Subjects, *J. Allergy* **6**:304, 1935.

of colds normally seen in nonallergic persons. It is recorded<sup>9</sup> that patients who have pollen hay fever also have symptoms during the pollen season from other allergens, to which they are not sensitive at other seasons of the year. This is one of the accepted reasons for failure to get results from pollen treatment when patients are not being desensitized to the offending allergens. The picture differs in no way in the patient sensitive to cold virus or its toxins. It must be appreciated, therefore, that of the numerous factors which predispose persons to colds, allergy is probably one of the most important, a factor long overlooked because of the failure to evaluate the condition properly during its formative stage. Unless the allergic state is eradicated, immunization to colds will continue to be the dismal failure it has been thus far, for the allergic person presents sensitization to the cold virus as well as to other allergens.

RECURRENT ACUTE LARYNGITIS, PACHYDERMIA LARYNGIS,  
SINGERS' NODES AND PAPILLOMAS

Laryngeal conditions which frequently are due to an allergic diathesis are recurrent acute laryngitis, pachydermia laryngis, singers' nodes and papillomas. These represent acute, chronic, diffuse and circumscribed hyperplastic changes in the tissues of persons who reveal similar changes throughout the nasal, sinal and pharyngeal mucosa. McKenzie,<sup>10</sup> in discussing the etiology of chronic laryngitis, stated that "the pachydermatous or hyperplastic type is often part and parcel of a constitutional tendency to fibrosis." It is not our contention, of course, that such conditions are always allergic, but it may be said that they are frequently seen in allergic patients.

Most investigators concede the frequency of pathologic changes in the nasopharynx in laryngeal conditions. Babbitt<sup>11</sup> makes the observation that acute laryngitis is usually seasonal, with regular recurrence in spring and autumn. This, of course, suggests a relation to the pollen seasons. We, too, noted this repetition of acute laryngeal conditions, but we also found them occurring in most allergic persons with each cold in the head, a concurrence which we noted particularly in borderline allergic patients not having manifest allergy or concomitant eosinophilia either in the secretions or in the tissues themselves. On the other hand, we have never been able to substantiate such conditions as autointoxica-

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9. Surneford, O.: *Physical Allergy*, J. Allergy **6**:175, 1934.

10. McKenzie, D.: *Diseases of the Throat, Nose and Ear*, St. Louis, C. V. Mosby Company, 1928.

11. Babbitt, J. A.: *Acute Laryngotracheitis*, in Jackson, C., and Coates, G. M.: *The Nose, Throat and Ear and Their Diseases*, Philadelphia, W. B. Saunders Company, 1939.

tion, intestinal toxemia and defective elimination as etiologic factors in acute laryngitis, though these conditions are frequently mentioned as causing acute or chronic laryngitis.

Chronic laryngitis includes low grade inflammatory conditions which result in local or general hyperplastic changes throughout the larynx. Like hyperplastic disease of the nose, it is characterized by an overgrowth of all connective tissue, particularly in the areas most exposed to trauma by secretions, air or physical impact. These areas are, of course, the cords, the interarytenoid space, the arytenoids and the ventricular bands. Lederer<sup>12</sup> stated that the continuous postnasal dripping of irritating secretions into the pharynx and larynx predisposes these areas to hypertrophic and hyperplastic changes. This opinion is generally accepted by most laryngologists, but we feel that it is particularly true for persons having a hyperplastic diathesis, for they have like changes throughout the respiratory tract, from the uppermost nasal and sinal mucosa to the terminal bronchioles. This phenomenon may be compared to that noted in persons who are subject to keloids, except that the process occurs in a different system of the body. The absence of eosinophils in the affected tissues has perhaps caused observers to overlook the frequency of allergic taint in the patients. We must reconcile ourselves to the fact that only during an active allergic storm do eosinophils appear. Autopsy on material taken from hyperplastic areas throughout the larynx in persons who have died during an attack of asthma reveals an abundance of eosinophils.

The diagnosis of allergy must be made from a careful family and individual history, together with a complete allergic cutaneous survey. Typical cases demonstrating the conditions outlined are as follows:

CASE 1.—L. D., aged 33, stated that as a child he had numerous attacks of croup following colds in the head. After reaching adult life he suffered constantly from a stuffy nose but never sneezed except with a cold. For the past ten years he has been subject to colds throughout the winter, lasting about two weeks and associated with hoarseness. Following his last cold he continued to be hoarse for five months. Except for a history of asthma in 1 parent, nothing else of significance was noted. Physical examination revealed hyperplastic changes throughout the nose, pharynx and larynx and a papillomatous growth about the size of a raisin on the left cord. This was removed and sectioned. The diagnosis was benign papilloma. A foreign protein survey revealed a 3 plus reaction to dust, ragweed, grasses, wool, extract of cold virus, flaxseed, beet, buckwheat, cheese and duck. The basal metabolic rate was —12 per cent; the chloride content of the blood was 432 mg. per hundred cubic centimeters, and the sugar tolerance was normal. Immunization to the materials mentioned, carried out weekly for one year, has resulted in freedom from nasal symptoms for the past eighteen months. Con-

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12. Lederer, F.: *Diseases of the Nose and Throat*, Philadelphia, F. A. Davis Company, 1938.

current with this treatment the patient was given 1 grain (0.06 Gm.) of thyroid and 45 grains (2.9 Gm.) of sodium chloride daily. The patient was referred for instruction in the use of the voice and proper breathing.

CASE 2.—M. A., a girl aged 14, complained of hoarseness of six months' duration. A history of numerous colds since early childhood was given. She had had eczema in infancy. There was nothing else significant in the history except that the mother has suffered from headaches most of her life. Examination revealed hyperplastic changes throughout the nose and pharynx. Singers' nodes were present on the cords. A foreign protein survey revealed sensitivity (2 and 3 plus) to combined grasses, combined ragweed, dust, extract of cold virus, lemon, carrot, cucumber, walnut, veal, poppyseed, spinach, paprika, mushroom, celery, beef, tomato, olive, orange and green pepper. The basal metabolic rate was —20 per cent; chloride content of the blood was 442, and the sugar tolerance curve was normal. Progressive injections of the inhalant material were given weekly with 2 grains (0.13 Gm.) of thyroid daily. The child continued at school, using her voice. The voice became decidedly better after the eighth week and was normal after the twelfth week, although the former position of the nodes was just discernible. The treatment was continued for one year. There has been no recurrence to date, about two years since the beginning of treatment. Immediately after the disappearance of the nodes, the child was referred to a voice teacher for instruction in breathing and the proper use of the voice.

CASE 3.—Mrs. T. W., aged 57, had suffered from continuous loss of voice for three months. She had had asthma in childhood and suffered from about ten colds each year, always followed by attacks of laryngitis lasting approximately two weeks. Her mother was asthmatic. Laryngeal examination revealed uniform thickening, with numerous excrescences involving both vocal cords. Biopsy revealed chronic granulation tissue, i. e., hyperplasia. The diagnosis was pachydermia laryngis. Nasal examination revealed high grade hyperplastic changes throughout the nose and sinuses, with polypi in both middle meatuses. An allergic survey revealed sensitivity (3 and 4 plus) to ragweed, grasses, horse serum, wool, extract of cold virus, orris, camel dander, feathers, rabbit dander, cow dander, dust and pyrethrum. The patient was immunized to grasses, weeds, dust, wool and cold virus. After the third month the condition was greatly improved. The voice was normal after the fifth month. The patient has remained under treatment for a period of eighteen months, during which time her voice has remained normal.

#### CHRONIC PURULENT DISCHARGE FROM THE NOSE IN CHILDREN

Chronic purulent nasal discharge in children, associated with purulent pansinusitis, has long been the enigma of both pediatrician and rhinologist. Because of their habit of concentrating their efforts on the drainage of one or two particular sinuses, as is done for postscarlatinal conditions, rhinologists often forget to investigate the condition from its onset. However, in all the cases, if a careful history is taken one is impressed by the frequency of an allergic family history or even other allergic manifestations, particularly food problems in early infancy. The masking of the allergic condition by a chronic suppurative process is so complete as to make it impossible to diagnose it from physical findings or signs, so that dependence must be placed on a careful individual and family history. An illustrative case is as follows:

M. F., aged 5, according to his mother had presented a pediatric problem since early childhood, having had a purulent nasal discharge since he was 18 months old. He had always been a difficult feeder and had had bronchiopneumonia twice and colds constantly throughout the year. He had had drainage of the antrum numerous times and his adenoids removed twice. There was a history of an aunt having lay fever and the maternal grandmother having asthma. Examination revealed highly thickened membranes throughout the nose, with much purulent exudate present. There were large amounts of lymphoid tissue in the pharynx. At the time of examination he was hoarse. A foreign protein survey revealed reactions (2 and 3 plus) to ragweed, grasses, dog hair, house dust, horse serum, lynx, mole, muskrat, rabbit, pyrethrum, lima bean, kidney bean, American cheese, Roquefort cheese, corn, white potato, shrimp, tomato, veal, *Monilia oidium*, *Monilia sitophilia* and cold virus. Because of the patient's unruliness, it was impossible satisfactorily to carry out studies of the basal metabolism or of the sugar tolerance or the chloride content of the blood. The patient was immunized by weekly injections of ragweed, grasses, dust and cold virus and received weekly irrigations of the posterior sinuses. After five months of treatment the condition entirely cleared. The patient has continued to receive monthly treatments for the past year, without any recurrence of his former symptoms. It is significant that during the past epidemic of influenza all 5 members of his family were stricken, he and an aunt, who was also immunized, being the only ones to escape.

#### TUBAL-TYMPANIC CATARRH

Nonsuppurative conditions of the tubal-tympanic system are a natural sequence of pathologic changes in the nose and pharynx. The intimate connection of these systems through physical proximity, vascular and lymphatic continuity and similarity of protective mechanism causes them to share alike inflammatory processes which involve the membranes. The mucous membrane of the tube and middle ear is lined by a ciliated columnar epithelium, which, though slightly modified, is actually an extension from the nose and pharynx. It is a membrane rich in lymphatics and blood supply, constantly bathed by its own secretions and that from the nasopharynx. When the inflammation is acute the cells associated with a similar condition of the nose and pharynx are noted, for instance, round cells, histiocytes, fibroblasts and leukocytes. When the predisposing factor is an active allergen, eosinophils may appear throughout the mucosa. If, however, the activating allergens are mild and the condition goes on to chronicity, hyperplastic changes occur similar to those noted in the nose and pharynx. In the borderline allergic patient the changes in these membranes consist of thickening of the membrane due to increase in connective tissue elements and edema. The cilia are frequently lost, and metaplasia may take place. The predominant cell, as in the nasal and pharyngeal mucosa, is the round cell, with only a normal number of eosinophils. Only in an active allergic state do the eosinophils appear. It should not be difficult to understand, then, why about 25 per cent of patients with active hay fever suffer from symptoms referable to the tubal-tympanic system.

Proetz was quoted by Turner<sup>13</sup> as holding that in certain cases non-suppurative otitis media is due to allergy. We have noted that about 65 per cent of our patients with hyperplasia, all of whom are borderline allergic patients, suffer from symptoms referable to the tubal or the tympanic region. This is particularly true of patients with long-standing hyperplasia who suffer from postnasal drip and intermittent obstruction, as described earlier in this paper. Stuffiness of the ears and tinnitus are the two most prominent symptoms of which these patients complain, symptoms which disappear when immunization is attained. Those in whom definite low tone deafness is proved by tests with the audiometer and the tuning forks, though immunization does not remedy this condition, react more rapidly and permanently to regular aural treatments such as catheterization.

#### TREATMENT

The treatment of borderline allergy is directed solely toward alleviation of the allergic diathesis. Surgical procedures and quasiscientific physical therapeutic methods, though seemingly of some temporary benefit, are in the end injurious, since they only result in fibrosis and a nervous and vascular chaos which ultimately causes a far greater vasomotor upset than was originally present. Along with the allergic study, a glandular survey should be conducted, including careful determination of the basal metabolic rate, the chloride content of the blood for insufficiency of the adrenals and the tolerance of sugar for pancreatic insufficiency and uterine scrapings for ovarian insufficiency. It must be borne in mind that, since the conditions are only mildly allergic, more concentrated materials must be used for testing. The danger of shock from the use of concentrated allergens is minimized in such patients because of the mildness of their condition and response to offending allergens. The use of concentrated allergens is likely to bring out a number of false positives, particularly among the foods. As in frank allergic conditions, however, they must be checked by trial in the diet to determine their clinical significance. It has been our observation that in adults the inhalants are preponderantly the greater etiologic factors in hyperplastic disease of the respiratory tract, while the converse is true in young children.

#### SUMMARY

1. The difficulties in properly evaluating the symptoms and pathologic changes of hyperplastic disease of the respiratory tract cause the borderline conditions to be falsely grouped in classifications which belie their allergic nature.

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13. Turner, A. L.: *Diseases of the Nose, Throat and Ear*, Baltimore, William Wood & Company, 1936.



2. Neither the texture nor the color of the tissues nor the character of the exudate gives any hint of the allergic nature of the borderline condition, since pallor, edema and eosinophilia are usually not present.

3. Borderline allergy of the respiratory tract is diagnosed by the finding of gross hyperplastic changes in a person with a history of allergy or in whose family there is a history of allergy and in whom a foreign protein survey reveals positive sensitivity to particular allergens.

4. There is excellent evidence in many cases of the allergic nature of the following diseases when found in persons with hyperplasia:

- A. Chronic intermittent nasal obstruction.
- B. Chronic lymphoid pharyngitis.
- C. Frequent colds.
- D. Recurrent acute laryngitis, pachydermia laryngis, singers' nodes and papillomas.
- E. Chronic purulent discharge from the nose in children.
- F. Tubal-tympanic catarrh.

Limitation of space prevents publication at this time of any great amount of corroborative evidence, so that these observations must be considered a preliminary effort.

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# SPEECH HEARING AND SPEECH INTER- PRETATION TESTING

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PHILADELPHIA

The degree of deafness as determined by the audiometer, does not give even an approximate idea of the difficulty the patient may have in hearing the voice. It is the handicap for the voice that really counts. (Shambaugh Sr.)

After all, what we and the patient are interested in, is not the patient's ability to hear a tone reproduced through a telephone receiver, but his ability to hear the spoken voice. It is common knowledge that some patients' appreciation of the spoken voice is better than the audiometer record would lead us to believe, and that other patients' hearing for spoken voice is actually worse than the audiometer would lead us to believe. It is my opinion therefore that his audiometer tests leave the practical otologist dissatisfied. (Wishart.)

It must be remembered that the audiogram which is a guide to the threshold for sounds at various frequencies is no indication of the quality of perception at these frequencies. (Kerridge.<sup>1</sup>)

Up to this time, audiometry has meant to most otologists the determination of pitch hearing. Yet, since there is little or no correspondence between the hearing for the various pitches and that for speech, there is a growing conviction that the only way one can determine speech hearing is by using speech as the testing stimulus. Any one working with the deafened is soon conscious that they are interested not in how well they hear pitches but in how well they hear the human voice. It behooves the otologist to pay more attention to speech hearing, since it is the concern not only of the patient but of the educator as well.

Certainly, the interest of laymen in the matter of hearing should be guided by otologists.

The only way the otologist can take his proper position is to obtain a thorough knowledge of the subject of speech hearing. To do this, he must become familiar with the acoustics of speech and the materials and methods available for testing the hearing of speech.

The acoustics of speech is outlined briefly in the following paragraphs:

## OUTLINE FOR A STUDY OF THE HEARING OF SPEECH

1. The chief function of the organ of hearing is to hear speech.

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Read at a meeting of the Philadelphia Laryngological Society, December 5, 1939.

1. Kerridge, P. M. T., in Ferguson, A.: Reports on Progress in Physics, London, Physical Society, 1939, vol. 5.

2. Speech and speech hearing are important.

3. A knowledge of the characteristics of speech and of the importance of the use and the phonetics of language should be the concern of otologists dealing with hearing.

4. The composition of language is as follows:

All language in any tongue is made up of vowel and consonant sounds. Vowels are more easily heard than are consonants, but proper consonant hearing is infinitely more important for the correct understanding of the word. In estimating the ability to interpret words, consonant hearing is given twice the value that vowel hearing is given.

5. All spoken language is characterized by the following factors:

Loudness of speech.

Speed of speech.

Voice register (high, medium or low pitched).

Sharpness of articulation or its opposite, elision.

Correctness in pronunciation.

Phrasing.

Accent.

Inflection.

Proper and improper use of words and grammar.

6. In relation to hearing, the spoken voice may be poorly heard for the following reasons: .

(a) Speech may be too low.

(b) Speech may be too fast.

(c) Speech may be slurred.

(d) Pronunciation may be incorrect.

(e) The words used may be unfamiliar.

(f) Words may be used improperly in relation to meaning.

(g) Words may be used improperly as to grammatical construction.

(h) Pronunciation may not give the proper vowel and consonant sounds.

(i) Stuttering, stammering and lateral emission are obvious speech faults which make for difficulty in understanding. Dyslalia, the speech of the mentally retarded, or of patients with paralysis of the facial nerve, is difficult to interpret. Foreign accent is often as bad.

The English language is particularly difficult in three respects:

1. Words are not pronounced as they are spelled. 2. Words with different spelling may have the same pronunciation. 3. Words with the same spelling are pronounced differently.

## EXAMPLES

Pair, pare, pear.	} Pronounced alike but spelled differently
Mite, might; site sight.	
Sley, slay; see, sea; kind, cake.	
Dear, deer.	
Dun, done.	

(A foreigner following rules of pronunciation cannot understand why "done" is pronounced "dun" while "dome" is pronounced with a long "o.") *Close* to home, *close* the door—spelled alike but pronounced differently.

There is a greater list of vowels than one would suppose. A reference to a brief on the "Scientific Alphabet" (Funk and Wagnalls' Standard Dictionary, 1895, pages 2104-2107) will give an idea of the confusions and complexities which the language presents even for philologists.

## EXAMPLE

There are varying pronunciations of the vowel "a"—far, fare, fat, partake, abase. This one vowel has been classified under types as follows: strong, variant, obscure, short, long.

The vowel "e" is "short, long, variant, obscure or silent."

The vowel "i" is short, long, obscure or diphthongal.

The vowel "o" is short, long, variant or obscure.

The vowel "u" is short, long, obscure or diphthongal.

If one considers that each of these variations means acoustically a distinctly different sound, one realizes that there are at least twenty-five different sounds representing simple vowels. The list would be greatly enlarged by adding all the diphthongs and the semivowel "y".

The consonant list is not so complicated, yet it too contains many more sounds as spoken language than the twenty-one consonant characters suggest. "K" is equal to "C" in most cases—cake, kind, cook, kite, cut, keen, cool, kill. This should reduce the count, but many consonants may be "hard" or "soft" or compounded into distinctly different sounds (ng, ch, st, tch, th). The combination gh may be silent, as in "through" and "though." How can one explain "enough" (enuff)?

Much conflict exists between spelling and pronunciation (ph = f [phonograph]). Sounds are often not spoken as spelled, nor spelled as spoken.

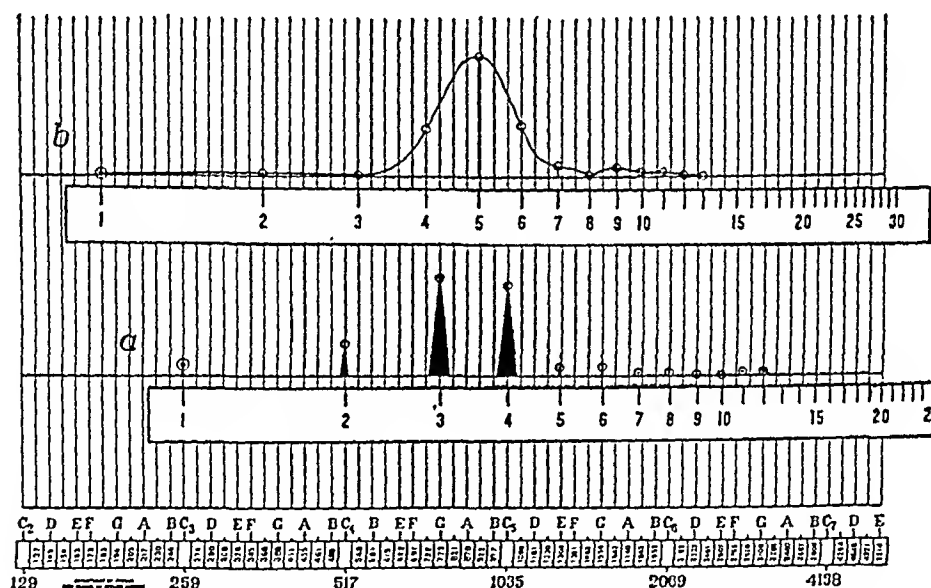
#### THE SIGNIFICANCE OF THE PHONETICS OF SPEECH TO THE OTOLOGIST

Speech represents an infinite variety of sounds or frequencies. Some are noisy; some are musical; some are explosive, sibilant, resonant, aspirated, nasal, soft, hard, loud, thin or rich in tone color. Each sound pattern has a meaning or significance. For each, there are a memory and an association.

One realizes the exquisite sensitivity of the hearing mechanism when it can receive, transform, amplify, transmit and perceive thousands of frequencies coming in the most rapid succession, as in speech.

Dayton C. Miller, in analyzing the vowel "a" as in "father," showed that sixteen major frequencies make up its character. One can then conceive that in a short spoken sentence there are thousands of pitches presented. Their interpretation and the dampening out of them must be practically immediate. It is understood, then, that such a finely functioning organ must be a most delicate, critical mechanism, as are most highly differentiated organisms.

It is surprising that the mechanism of hearing is not more often or more seriously damaged than it is.



On the Western Electric audiogram chart there is a footnote that the percentage of loss of hearing for speech is approximately equal to the average reading at 512, 1024 and 2048 multiplied by 0.8. This statement has unfortunately been accepted by many unfamiliar with testing for speech hearing. A large series of audiograms and of tests of speech hearing on patients shows that one cannot infer from an audiogram the efficiency of speech hearing.

The comparative findings from a summary of the records of 22 patients tested by the 2-A (pitch range audiometer) and the 4-A (phonograph) instruments are listed as follows. The records have been translated into speech hearing by the Fletcher method (the average of the loss in decibels for the frequencies 512, 1024 and 2048 multiplied by

2-A Record (Pitch Range Audiometer)	4-A Record (Phonograph)
4	00
24	12
18	00
20	9
22	6
8	6
48	30
16	9
25	12
10	0
9	6
46	3
13	15
24	15
26	15
22	12
44	18
9	3
34	18
10	0
12	0
45	12
<hr/> 489	<hr/> 201

0.8 equals the percentage of speech hearing). The numbers indicate percentage of loss of hearing.

The 22 comparisons between the two methods show that there is a variation in the order of 22:9, the 2-A method showing higher losses of hearing.

#### METHODS AND MATERIAL

*Speech hearing can be tested only by the use of speech as the test stimulus.*

The motor-driven phonograph, with its electrical pick-up and decibel meter, has revolutionized testing for speech hearing. With this instrument, any desired intensity may be obtained and repeated with identity. The word lists and the material used in the records should be selected with great care, as to articulation, quality of recording, needle scratch and familiarity of the words used. I have found the following word list useful. It represents a selection of 50 monosyllables from the words

most commonly used in the English language, based on Gate's list of the first 50 words in frequency of use.

The	Make	We	Get	Had
I	One (adj.)	It	Two	Your
Is	One (noun)	Me	His	Give
To	Do	Of	Are	Mother
In	For	My	Her	Up (prep.)
You	Be	Boy	Play	Up (adv.)
He	All	Our	Day	Home
On	See	Man	Have	Made
No (adv.)	Go	Come	Big	Red
No (adj.)	At	A	Run	Eat

The frequency of the various vowel sounds in the list is as follows:

ē.....5	oo.....4	n (make).....5	ou.....1
ē.....7	o (on).....6	n (all).....2	u.....3
i.....2	o (no).....4	n (at).....4	u.....2
u.....6			

As familiarity with words largely determines their interpretability, a still larger list is important to consider and to use for testing words which appear more frequently in speech. Much work has been done in actually counting the instance of various words, and graded vocabulary lists have been made showing the size of the vocabulary for children of different ages. Naturally, the vocabulary of the adult depends on his education. In the following abstract from Thorndyke's classic list are monosyllables selected from the first 500 words in frequency of use in the English language, from a list of 4,265,000 words. These monosyllables comprise 90 per cent of the list. These words are familiar to all persons over the age of 6. The list is useful in investigating the size of the hearing vocabulary of the deafened child and may also be used in teaching this child the important words in the language.

(A)	Come	Food	How	Men	Rain	South	Town
Add	Corn	Foot	(I)	Might	Raise	Speak	Train
Air	Cross	(For)	If	Milk	Reach	Spring	Tree
(All)	Cut	Form	(In)	Milk	Read	Stand	True
Am	Dark	Four	Is	Mild	Red	Start	Try
An	Day	Free	It	Mine	Rest	State	Turn
(And)	Dead	Fresh	Its	Miss	Rich	Stay	To
Any	Dear	Friend	Just	Mouth	Ride	Step	Up
Are	Death	From	Keep	More	Right	Still	Us
Arm	Deep	Front	Kill	Most	Road	Stone	Voice
(As)	Did	Full	Kind	Move	Rock	Stop	Wait
Ask	Die	Gave	King	Much	Roll	Story	Want
(At)	Do	Get	Know	Must	Room	Street	Walk
Back	Does	Girl	Known	My	Round	Strong	Wall
Bad	Done	Give	Land	Name	Run	Such	Wax
Ball	Door	Glad	Large	Near	Said	Sun	Warm
Bank	Down	Go	Last	Need	Sail	Sure	Was
(Be)	Draw	God	Late	New	Same	Sweet	Watch
Been	Drink	Gold	Laugh	Next	Save	Take	Way
Bed	Drive	Great	Law	Night	Saw	Talk	We
Best	Drop	Green	Lay	No	Say	Tell	Week
Big	Each	Grow	Lead	North	Sea	Ten	Well
Bird	Ear	Had	Learn	(Not)	See	Than	Went
Bear	Earth	Hair	Leave	Now	Seem	Thank	Were
Black	East	Half	Left	(Of)	Send	(That)	What
Blow	Eat	Hand	Length	Off	Sent	(The)	When
Blue	Egg	Hard	Less	Old	Serve	Their	Where
Body	End	Have	Let	(On)	Set	Them	Which
Book	Eye	Has	Lie	Once	Shall	Then	While
Both	Face	He	Life	One	She	There	White
Box	Fair	Head	Light	Or	Ship	These	Who
Boy	Fall	Hear	Line	Our	Short	They	Whole

Bring	Far	Heart	Live	Out	Should	Thing	Why
Build	Fast	Help	Long	Own	Show	Think	Wide
Burn	Fear	Her	Look	Part	Side	Third	Wind
But	Feel	Here	Lost	Pass	Sight	This	Will
By	Feet	High	Love	Pay	Since	Those	Wish
Buy	Few	Hill	Low	Piece	Sing	Though	With
Call	Field	Him	Made	Place	Sit	Thought	Wood
Came	Fill	His	Make	Plain	Six	Three	Word
Can	Find	Hold	Man	Plant	So	Through	Work
Care	Fine	Home	Many	Play	Soft	Till	Year
Cause	Fire	Hope	Mark	Please	Some	Time	Yet
Child	First	Horse	May	Point	Son	(To)	You
Clear	Five	Not	Me	Poor	Soon	Too	Young
Close	Floor	Hour	Mean	Put	Sound	Top	Your
Cold	Fly	House	Meet	Quick			

The 6 words in bold face type are the most commonly used nouns. The words in parentheses are the 15 most commonly used words. Other useful records are based on lists of consonants and vowels.

Tool	Boot, boon	What is a tool?
Took	Book, buck	He took the train
Tone	Bone, boat	Do you like the tone?
Talk	Bought	Can animals talk?
Ton	Bog, box	Coal is sold by the ton
Top	Bar, bark	The boy plays with his top
Tap	Back, bat	I heard a tap
Ten	Bet, beck	He gave her ten
Tape	Bake, bait	He wrapped it with tape
Tip	Bit, bin	It was on the tip
Team	Beat, bean	John made the team
Time	Bite, bike	What is the time?

#### CONSONANT LIST FROM THE PHONETIC ALPHABET (110 WORDS)

Bed	Bird	Black	Book	Box
Day	Dark	Deep	Did	Die
Feet	Fire	Floor	Far	Feel
Girl	Go	Green	God	Get
Keep	Kill	King	Kind	Can (K)
Late	Long	Live	Look	Light
Man	Me	Milk	Mouth	More
Not	Now	No	Night	New
Red	Read	Rain	Ride	Road
Place	Pay	Plant	Poor	Put
Said	Saw	See	Send	Sit
She	Ship	Short	Show	Shall
This	Those	That	The	Them
Three	Through	Think	Thing	Thank
Time	To	Top	Tree	Try
Voice	(Vie)	(Vote)	(Vine)	(Vim)
Church	Child	(Choose)	(Shum)	(Chop)
(Zee)	(Zoom)	(Zip)	(Zee)	(Zoom)
Just	(Judge)	(Joke)	(Jack)	(Jake)
Hand	Hard	Head	Help	Her
Warm	Wait	Want	We	Walk
Year	Yet	You	Young	Your

These words, except those in parentheses, are monosyllables in the list of the first 500 in common use.

*Help in Choosing a Hearing Aid.*—One approach which the otologist can make toward breaking down the barrier between himself and the deafened is the service he can give in the selection of a hearing aid. The aids are relatively expensive for many such persons, and they are often suspicious, both justly and unjustly, of the salesman's desire to make a sale. The otologist may act as an impartial advisor as to whether a new aid will help hearing or whether it is better than the old aid.



With a set of speech records and a phonograph with a loud speaker, one may try out the hearing of the patient with and without his aid. With such equipment, one may determine what vowel or consonant sounds are most difficult for the patient to hear; one can tell how much intensity of sound is needed and whether low or high tones of speech should be dampened out.

*Determining if Hearing is Improved by Suppressing Low Tones.*—Every one is familiar with the change in pitch which occurs when a phonograph record is speeded up; music and speech both become more thin and squeaky.

Test: The threshold intensity for speech hearing is determined with the record running at the normal speed, 78 revolutions per minute. The intensity is turned down to a point at which the patient can hear 1 out of 5 of the test words correctly. Then the record is gradually speeded up. The low tones in the speech become less prominent; the pitch of the voice rises. Though the test words come more rapidly and give less time for the patient to interpret, most of the deafened show an increase in the number of correct responses. One knows, then, that in this case a hearing aid picking up or exaggerating low tones is neither needed nor desirable.

*Determining if Hearing is Improved by Suppressing High Tones and by Increasing Low Tones.*—By reversing the foregoing method, the patient is first tested with a record turning faster than normal. The intensity is reduced until an occasional word is answered correctly (1 out of 5). The speed of the record is then reduced to normal, and the patient's hearing either improves or is worse, as shown by the number of correct answers. (A stroboscopic disk placed on the turntable determines the normal speed of the record, 78 revolutions per minute. These disks may be obtained from any large phonograph agency.)

*Testing the Speech Hearing of Very Young Children.*—With young children, Crowden's method is used. A series of words which represent the simplest and first-learned words in the language is selected and recorded. With a picture card in front of him the child can point out the object named. The test becomes a game to the little patient, and he is eager to make a correct performance. The method is much more accurate with timid children than if they had to speak out their answers.

*Judging Central Perception.*—Apart from the ability shown by a patient in hearing a phonograph record of simple speech sounds, there is with every person a certain degree of agility in central perception. Two persons may show identical hearing with the phonograph audiometer, both requiring the same decibel amplification for correct

reporting, yet one of them may have much more difficulty in hearing conversation than the other. Why?

The answer is not easy, for a number of factors take part, as in the following illustration: Two persons have the same amount of distortion of hearing; although their frequency audiograms show their distortions to be at different frequency levels, they report on the simple speech record at the same amplification. But when listening to conversation, one person shows confusion and difficulty; the other does not. The mental attitude plays an important part.

Many a deafened person fears to appear confused, dull or stupid. The fear itself brings more confusion and possesses the person to such an extent that he is distracted from listening intently. At times he has picked up a few words which have led him to believe that the subject matter is following a certain line. Then, suddenly, he hears a word that does not possibly fit into the trend. For example, "My *brother* is very fond of a *pipe*, but he throws matches *all over the house*." Only the italicized words were heard, and some meaning has been obtained from the first part of the sentence by the hearing of the two words "brother" and "pipe." But what can the phrase "all over the house" mean, when it is standing alone? "It must have something to do with 'pipe' or 'brother,' but what"? If he stops to wonder, the next sentence in the conversation is on him, and he is not ready for it. (It is obvious from this why one gives the deafened person a better chance if one speaks slowly as well as distinctly).

Familiarity with phrases and forms of speech undoubtedly plays a part in central perception. Practice in listening exalts this ability.

General knowledge and a good education should improve the agility in correctly interpreting what is partially heard.

Attention is a most important factor in central perception. There are all degrees of it with the deafened. Some show a quick arousing and a sharp focusing; others have to have their hearing warmed up by speech louder than necessary. Some, it seems, have to be shaken out of their lethargy or their absorption.

*Testing Hearing Agility.*—I think it is well to test the patient first for the sharpness of the hearing threshold, which is itself a good index of agility. This testing is done by recording the threshold when going from inaudible to audible and then recording the threshold in going from audible to inaudible. If the two thresholds match each other or are near each other, good acuity may be anticipated. (The "audible to inaudible" should give the lowest threshold, yet care should be taken when one is working with tones instead of words that the patient does not develop tone memory and thus mentally carry the tone down. One

should use the sound stimuli irregularly on and off or swing the pitch back and forth in the zone of the frequency tested.)

Seashore's records for testing musical talent are certainly tests in the perceptive or interpretive spheres rather than tests of gross hearing ability. This is particularly true of the test for the discrimination of intervals (time) between notes. Pitch discrimination tests, on the other hand, do not seem to correlate with agility, nor does the test for dissonance or consonance. The tone memory test tends to show the best results in those with good auditory agility.

I have devised a test which promises fairly dependable quantitative data and is simple and rapid. A series of 10 carefully chosen words is recorded in successive bands on a record. The sequence is scrambled for each band, but the words are the same. The interval between the individual words on the bands is 10, 8, 6, 4 and 2 seconds for the respective bands. The intensity level of the record is set for convenient hearing, and this loudness is recorded in the reporting along with the loss of speech hearing decibels. Age, of course, is a noticeable factor in this test, as Seashore found in his tests, and a child's agility must be judged with consideration of the "rough-normal" for his age. It is obvious that those with poorest agility will not be able to report on the short interval bands as correctly as on the long interval bands.

#### QUESTIONS AND ANSWERS

Q. What is meant by the term articulation test as applied to hearing?

A. Articulation testing is the determination of the ability to recognize speech sounds. If mistakes are made in interpreting correctly the spoken word or syllable, it may be "desirable to further analyze these mistakes and determine the articulation of speech sounds. The percentage of the total number of spoken sounds which are correctly observed is called the *sound articulation*. When the attention is directed toward a specific fundamental sound, such as 'b' or 't' or 'a,' etc., then the term *individual sound articulation* is used. For example, the individual sound articulation for 'b' is the percentage of the number of times that 'b' was called that it was observed correctly. Similarly, the terms *consonant articulation* or *vowel articulation* refer to the percentages of the total number of spoken consonant or vowel sounds which are correctly observed." <sup>2</sup>

Q. When English words and short sentences are used as testing stimuli, what should this testing be called?

2. Fletcher, H., and Steinberg, J. C.: Articulation Testing Methods, Bell Telephone Laboratory. This article is the most comprehensive one on the values of speech sounds in the literature and will be of inestimable value to any person making a study of the subject.

A. Fletcher prefers and uses instead of the terms "word articulation" and "sentence articulation," the terms "discrete word intelligibility" and "discrete sentence intelligibility," since a new element enters, namely, the thought or meaning associated with the sentence or word.

Q. How much better should numbers be heard than common words?

A. Numbers are usually heard or recognized 10 decibels lower than words.

Q. To hear sentences perfectly, what must be the percentage of correct word hearing?

A. Articulation has to be 70 per cent efficient to obtain perfect sentence intelligibility, yet a mentally agile deafened person can understand correctly most of what is said with considerably lower performance in articulation.

Q. Does the patient's hearing have to be "warmed up" by listening to readily audible sounds before the best threshold showing can be made?

A. In many cases it does; this is especially true when some degree of attention deafness has become established.

Q. Are meaningless speech sounds practical for everyday testing by the otologist?

A. I believe that they are most impractical, particularly from the points of view of reporting (repeating), recording and grading.

Q. Are sentences useful in testing?

A. Not for quantitative measurement of speech hearing; intelligence, education and familiarity with phrases and ideas play too large a part. For example, "He took the train"; "What is the time?"; "Coal is sold by the ton." The correct words may too often be guessed.

Q. Does the needle scratch interfere with phonographic testing of speech hearing?

A. No, not appreciably. The modern light weight and tangential tone arm has reduced the scratch to a negligible factor.

Q. By auricular (central acuity) training may intelligibility be indefinitely improved?

A. Not indefinitely nor infinitely improved, yet even a 10 decibel improvement may make the difference between understanding no speech and understanding a considerable amount.

Q. Can the phonograph be used as a training instrument for the little child, deaf before acquiring the use of language, who has some hearing?

A. The phonograph is a distinctly helpful adjunct to the established methods of reaching and teaching language to the deaf child.

## CONCLUSIONS

The testing of speech hearing must be approached with an understanding of the characteristics of speech.

The patient is primarily interested in speech hearing.

There is no correlation between speech hearing and frequency hearing.

Speech hearing can be tested only by the use of speech as a testing stimulus.

The phonograph should be used in place of the old test with the spoken voice.

A knowledge of testing for speech hearing and the proper equipment should be in the armamentarium of every otologist.

1805 Chestnut Street.

# Case Reports

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## NASOPHARYNGEAL CARCINOMA

### Extension Intracranially and Metastasis by Implantation into the Soft Palate; a Clinical and Pathologic Study

AMIL C. BACH, M.D.; FRANCIS L. LEDERER, M.D.,  
AND S. N. PALEVSKY, M.D., CHICAGO

The following case of carcinoma of the nasopharynx presents several features interesting not only to the otolaryngologist but also to the neurologist, the ophthalmologist, the roentgenologist and the pathologist. It is presented because of its value to both the clinician and the pathologist in that an attempt has been made to explain clinical symptoms from a complete study at autopsy.

Of further interest was the intracranial extension of the tumor with marked destruction of bone, metastasis to the liver and an apparent implantation of tumor cells by contact from the growth in the nasopharynx to an ulcer on the nasal surface of the soft palate. This ulcer approximated and was irritated by the tumor in the nasopharynx on phonation and swallowing.

That malignant tumors of the nasopharynx are not uncommon is evidenced by the abundance of literature on the subject, many authors reporting fairly large series of cases. It was our good fortune to study more minutely the pathologic anatomy of a case which we had observed clinically and in which we were allowed unrestricted material for autopsy.

Trotter<sup>1</sup> stressed the nasopharynx "a region rich in pathologic interest and subject to the growth of numerous tumours, which are by no means infrequent and are of great diagnostic importance." He directed attention to that class of growth which produces little or no projection into the nasopharynx and is therefore dismissed as having little diagnostic interest and to the tumor which projects into the nasopharynx and gives rise to obvious symptoms. He particularly stressed the importance of recognizing the former and stated that "diagnosis is entirely dependent upon recognition of the symptoms of infiltration of the naso-pharyngeal wall. . . . The strictly anatomical distribution of the symptoms is always a striking feature." He emphasized a triad of symptoms which should focus attention to such lesions of the nasopharynx, viz.:

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Read at the Sectional Meeting of the American College of Surgeons, Winnipeg, Manitoba, Canada, March 31, 1939.

From the Department of Pathology, Cook County Hospital, and the Department of Laryngology, Rhinology and Otolaryngology, Research and Educational Hospitals, University of Illinois College of Medicine.

1. Trotter, W.: On Certain Clinically Obscure Malignant Tumors of the Nasopharyngeal Wall, *Brit. M. J.* 2:1057 (Oct. 28) 1911.

1. Pressure on the eustachian tube, causing impairment of hearing.
2. Pain of the trigeminal nerve, especially of the third branch.
3. Asymmetry of the soft palate due to the pressure of a large mass or to direct involvement by the tumor of the levator palati muscle.

The groupings of symptoms which occur may be divided according to whether they indicate involvement of the respiratory tract, the ear, the nerves, the eye or the body as a whole or whether they arise from metastases. Closure of the jaw is usually a late manifestation. Enlargement of the cervical glands is a constant feature in late phases.

New<sup>2</sup> called attention to remote symptoms referable to one ear, diplopia or regional metastases as common early signs. Woltman,<sup>3</sup> in reporting 79 cases, stated that the cranial nerves are usually involved extracranially. Those passing through the orbital fissures are most commonly affected, particularly the sixth, and, next most frequently, the trigeminal.

Hansel<sup>4</sup> in reporting 17 cases, remarked that comparatively few cases have been reported in which the diagnosis was based primarily on involvement of the nervous structures. Needles<sup>5</sup> discussed the tumors with special reference to the neurologic complications, emphasizing the failure to establish an early diagnosis, and stated, "Unless, therefore, when confronted by a basilar syndrome, one associates it with a possible focus in the nasopharynx, the diagnosis may be overlooked." In 16 of his 35 cases neurologic involvement was evidenced. The most common symptoms were sensory disturbances of one side of the face, oculomotor disturbances, ptosis and diplopia. The cranial nerves usually affected were the fifth, sixth, third and fourth. If the tumor invades the skull, it tends to remain extradural. Furstenberg,<sup>6</sup> in describing 40 cases of malignant neoplasms of the nasopharynx, stated:

It is a noteworthy fact that these neoplasms show a striking tendency to infiltrate upward, erode bone, and eventually disturb those structures which pass through the basal foramina. . . . Of practical importance, therefore, is the observation that these new-growths often assume enormous proportions and consequent destructive behavior long before there is unmistakable evidence of their existence.

The most common symptoms which he noted were pain in the head, ear or throat, cervical swelling, deafness or fulness of the ear, nasal obstruction, nosebleeds, double vision and paralysis and swelling of the face. Hauser and Brownell<sup>7</sup> presented a series of cases, detailing a group of symptoms and signs which often lead to correct diagnosis,

2. New, G. B.: Syndrome of Malignant Tumors of the Nasopharynx, *J. A. M. A.* **79**:10 (July 1) 1922.

3. Woltman, H. W.: Malignant Tumors of the Nasopharynx with Involvement of the Nervous System, *Arch. Neurol. & Psychiat.* **8**:412 (Oct.) 1922.

4. Hansel, F. K.: Malignant Tumors of the Nasopharynx with Involvement of the Nervous System, *Ann. Otol., Rhin. & Laryng.* **41**:74 (March) 1932.

5. Needles, W.: Malignant Tumors of the Nasopharynx, *J. Nerv. & Ment. Dis.* **86**:373 (Oct.) 1937.

6. Furstenberg, A. C.: Malignant Neoplasms of the Nasopharynx, *Surg., Gynec. & Obst.* **66**:400 (Feb.) 1938.

7. Hauser, J., and Brownell, O.: Malignant Neoplasms of the Nasopharynx, *J. A. M. A.* **111**:2467 (Dec. 31) 1938.

and emphasized that the nasopharynx should be given careful and routine inspection by the rhinologist.

Schlivek<sup>8</sup> from his study of 38 cases concluded that involvement of the fifth, sympathetic and sixth nerves, either individually or in combinations, with symptoms referable to the ear, is strongly suggestive of nasopharyngeal tumor and that the presence of signs of involvement of the eye indicates that the tumor has already invaded the skull.

These, as well as other authors, including Martin,<sup>9</sup> have pointed the way to early recognition of malignant growths of the nasopharynx. We believe that such a growth should be strongly suspected in the presence of neurologic symptoms, such as headache, trigeminal neuralgia, paralysis of the abducens nerve, diplopia, oculomotor or trochlear paralysis and defective hearing. These signs, together with an associated conductive type of deafness, can lead to the correct diagnosis. Unfortunately, even at such a stage, the prognosis is usually poor and treatment unsatisfactory. Swelling of the cervical glands may occur early but usually is a late manifestation.

#### REPORT OF A CASE

*History.*—A. P., a white man aged 49, employed as an engineer, first presented himself at the Research and Educational Hospital in July 1938 with the following complaints:

1. Headaches and dizziness of three years' duration.
2. Epistaxis of two years' duration.
3. Diplopia of nine months' duration.
4. Internal strabismus of the left eye of nine months' duration.
5. Internal strabismus of the right eye of four months' duration.

The past history was noncontributory except for a nasal and postnasal discharge of several years' duration.

The family history was essentially irrelevant except for one brother having died at the age of 36 of a sarcoma.

*Present Illness.*—Three years previously the patient had consulted his family physician, complaining of epigastric distress, nausea and vomiting, dizziness and dull frontal, temporal and occipital headaches. The nausea and vomiting occurred about one to two hours after meals. Alkaline powders were prescribed, and the gastric symptoms were relieved, but the headaches and dizziness persisted, becoming more frequent and severe.

Two and one half years previously he had noticed ringing in both ears; at the onset the ringing was intermittent, but during the last nine months it had been continuous. Two years previously he began to have nosebleeds, which continued intermittently and were often severe until death.

Nine months previously, while shaving, he noticed that he had difficulty in placing the razor against his cheek because of double vision and turning in of his left eye.

He consulted an "eye doctor," who after treating him for three months referred him to the Illinois Eye and Ear Infirmary (six months previously). Roent-

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8. Schlivek, K.: Ocular Manifestations of Malignant Nasopharyngeal Tumors: Report of Cases, *Arch. Ophth.* **17**:1055 (June) 1937.

9. Martin, C. L.: Complications Produced by Malignant Tumors of the Nasopharynx, *Am. J. Roentgenol.* **41**:377 (March) 1939.



genograms, were taken of his head, and he was informed that he had "sinus trouble." Treatment consisted of irrigation of his sinuses and roentgen therapy, presumably to his sinuses. He was also given glasses, which helped his diplopia and enabled him to read for short periods. When he was refitted for glasses three months previously, it was noted that he had internal strabismus of the right eye also.

The patient had also complained of dyspnea for the past two months, as well as nocturia which disturbed him three to four times a night, and generalized muscular weakness for the past six months. He had lost 30 pounds (13.6 Kg.) since the onset of his present illness.

He was not improving; so he was admitted to the neurologic service of the Research and Educational Hospital on July 6, 1938, three years after the onset of his symptoms. He arrived with a slip stating that examination of the visual fields, eyegrounds, spinal fluid and blood gave negative results.

*Physical Examination.*—The pulse rate was 80; the blood pressure, 120 systolic and 70 diastolic. When admitted to the hospital in July 1938, the patient was a well developed, thin white man, about 50 years of age, apparently not acutely ill. His temperature and pulse rate while he was in the hospital were normal.

His skin was smooth and warm; seborrheic dermatitis was present over the sternum and back. The ears did not evidence tenderness over the mastoid, and the drums were retracted. The mouth showed numerous carious teeth. A postnasal discharge was present on the posterior wall. The neck was normal, and there were no palpable glands. Involvement of the first cranial nerve was evidenced by bilateral anosmia. That of the second was indicated subjectively by failing vision, with roughly no limitation of the fields, while objectively the fundi were normal. Examination of the third showed normal convergence and vertical movements; the pupils were equal and round and reacted sluggishly to light and in accommodation, and vertical nystagmus was seen in the right eye. The fourth and fifth were normal. Involvement of the sixth was suggested by bilateral internal strabismus. The seventh was normal. Examination of the eighth showed the subjective symptoms of tinnitus of two and one-half years', and diminished hearing of one year's, duration, while objectively it was noted that the patient heard a watch tick only when it was placed against his ears and that the bone conduction was better than the air conduction bilaterally. The ninth, tenth, eleventh and twelfth nerves were normal. The superficial and deep reflexes were normal. The chest was emphysematous, with increased tympany and fremitus and dry rales at the bases of both lungs. The heart, abdomen, trunk, extremities and rectum were essentially normal. Abnormalities of gait, posture or habitus were not seen.

In summary, the patient complained of headaches and dizziness for the past three years and diplopia for nine months. The only positive findings were bilateral internal strabismus, middle ear deafness and chronic pansinusitis.

The impression was that of a lesion of the sixth cranial nerve, which might be attributed to localized meningitis or to syphilis.

*Laboratory Examination.*—The urine was essentially normal. The erythrocyte count was 4,050,000, with hemoglobin 11 Gm. per hundred cubic centimeters; the leukocyte count, 10,570, with lymphocytes 12 per cent, monocytes 1 per cent, neutrophils 85 per cent and eosinophils 2 per cent. The spinal fluid was under a pressure of 140 mm. of water and clear, with a cell count of 3 (all lymphocytes), a negative Wassermann reaction and a 0000000 reaction to the colloidal gold test. Chemical analysis of the blood showed dextrose 83 mg. per hundred cubic centimeters, nonprotein nitrogen 35.6 per hundred cubic centimeters and a carbon dioxide-combining power of 64. The Wassermann and Kahn reactions of the blood

were negative. On roentgen examination the petrous tip showed, in Stenvers' position, no pathologic change. The skull viewed stereoscopically in the right lateral position showed no definite pathologic change. The sinuses revealed bilateral pansinusitis.

*Course.*—The report of a neurologic consultation July 8 stated: "The patient presents almost complete bilateral palsy of the sixth nerve. In looking upward with the right eye covered he experiences horizontal nystagmus of the left eye. There is no sense of smell, perhaps because of surgical intervention. The visual fields are roughly normal; the pupils are normal, and there is apparently no involvement of the third cranial nerve. All other cranial nerves are normal, except that there is obstructive deafness on both sides. The central nervous system is otherwise normal, except for rather brisk tendon reflexes. No pathologic reflexes are present. The diagnosis is a malignant growth with metastasis or some progressive lesion of the brain stem."

An otorhinolaryngologic consultation July 14 was reported as follows: "The nose shows thickening of the septum and deviation to the left. There is pus in both middle meatuses. The teeth are carious. The pharynx is small, with embedded tonsils. The ear drums are dull, gray, thickened and retracted. The hearing time measured by the Schwabach test is slightly diminished. The reaction to the Rinne test is bilaterally negative. Perception of low tones is poor; that of high tones, slightly diminished. A paretic type of ocular nystagmus is present, but no vestibular type. Spontaneous past pointing does not occur. A good caloric response is seen on both sides in nystagmus and past pointing, but function is not induced in the paralyzed external rectus muscles. No vertigo or vasomotor reaction is induced by vestibular testing. The diagnosis is a probable nonsurgical basal lesion."

The patient was discharged on July 16 with a tentative diagnosis of bilateral paralysis of the abducens nerve of unknown cause. He was advised to return at frequent intervals to the dispensary for further examination.

On August 15 no change was recorded.

On August 31 a flare-up of "sinus trouble" and also an increase in the severity of the neurologic symptoms were noted. The right eyelid was then drooping so far that the eye was closed. The patient had pain in the left side of the neck and face.

On September 8 there had been definite progress in the patient's condition; he then had complete oculomotor paralysis on the right, with drooping of the lid and inability to move the right eye in any direction. The patient was readmitted to the neurologic service of the hospital, where he was kept under observation until October 6, at which time he was again discharged with the following summary:

"This 49 year old white man was last in the hospital on July 16, 1938. At that time his condition was diagnosed as bilateral paralysis of the abducens nerve, possibly on an encephalitic basis. He has returned now because of complete paralysis of the third nerve on the right side. He has had constant severe headaches in the frontal region, and, in addition, he has a marked nasal and postnasal discharge. Roentgenograms revealed marked sinusitis, and he was given high voltage roentgen therapy with some relief and with some improvement of the paralysis of the third nerve. He is discharged with instructions to return to the dispensary for further observation and high voltage roentgen therapy."

On November 11 he was examined in the otorhinolaryngologic dispensary, and the following report was made:

"There is complete oculomotor paralysis on the right, with no reaction of the pupil, and also paralysis of the abducens nerve bilaterally. There is secretion on

both sides of the nose. The tongue can move to the left from the midline but not to the right. A large, firm gland is palpable on the left side of the neck.

"Massive irrigation of the left ear produces dizziness; the left eye shows typical nystagmus to the right; the right eye, only slight nystagmus to the right. Massive irrigation of the right ear produces dizziness and double vision, which was not present before. The left eye moves to the right and shows a rough rotary nystagmus to the left; the right eye does not move but reveals slight nystagmus to the left. Turning to the right produces dizziness, typical falling and nystagmus similar to that produced by irrigating the right ear.

"Examination of the nasopharynx reveals granulation masses surrounding the left eustachian orifice, almost hiding it from view. A specimen for biopsy was taken from this area.

"Examination of the larynx shows chronic laryngitis. The larynx and the pharynx are totally anesthetic. The patient has some degree of ankylostoma."

On November 29 a biopsy of the tumor in the nasopharynx was reported on as follows: "There are several fragments which include: (a) part of a nasal polyp revealing a folding-up of mucosa with hyperplastic transitional changes from tall columnar to pseudostratified epithelium, which has extensive inflammatory reaction and fibrosis (nasal part); (b) an adjacent area covered by thickened, semikeratotic squamous epithelium, which is everywhere demarcated. At one end of this fragment are massive strands of small, irregular flat cells. Whether these originated at the pharynx or from the nasal portion cannot be definitely decided from these fragments, but they are nevertheless malignant. The diagnosis is transitional cell carcinoma."

The patient was given high voltage roentgen therapy directed toward the nasopharynx and the glands on the left side of neck. He continued to have pain on the left side of his face.

On December 30 the patient had a severe spontaneous hemorrhage from the nasopharynx and was admitted to the Cook County Hospital, where he died the same day.

*Autopsy* (Dec. 31, 1938).—There was a grayish white tumor the size of a walnut in the right lobe of the liver and a smaller one in the left lobe. On gross sectioning these appeared grayish white, the larger containing a small cyst filled with blood-stained fluid. The brain appeared to be slightly compressed over the anterior inferior aspect; the meninges were thin, the blood vessels thin walled and patent and the convolutions flattened. The walls of the infundibulum were thinned, and there was slight internal hydrocephalus, especially on the left side.

On removal of the brain from the skull, the sella turcica was seen to be enveloped by a grayish white tumor, which was moderately firm, measuring 60 by 42 by 30 mm. By a method which allowed removal without collapse of the head, the base of the skull, including the nasopharynx, was removed, as were the soft palate, the tongue and the pharynx. In the nasopharynx, just beneath the sella turcica, a grayish white, moderately firm tumor was observed.

The removed specimen was carefully studied and revealed the following facts: The whole region of the hypophysis, both the cavernous sinuses and the anterior part of the clivus were invaded and occupied by a firm, light gray tumor, which was covered by dura (fig. 1). The dura had grown together with the tumor, and in places was thin, but at no point had it been penetrated. The tips of both petrous pyramids (fig. 1, 8) had been destroyed by the tumor. The vertebral arteries were normal; the basilar and the right cerebellar arteries were likewise normal. The right trigeminal nerve perforated the dura at the typical place and divided into

three branches, situated lateral to the neoplasm. On the left side, the third branch went through the foramen ovale in the typical way (fig. 1, 7), but the second branch had grown together in places with the tumor, and the first branch was completely embedded in it. The oculomotor and the trochlear nerves on the right side (fig. 1, 3 and 7) also entered the tumor and were embedded in the mass, whereas the left oculomotor and trochlear nerves (fig. 1, 2) were uninvolved and entered the superior orbital fissure. The optic nerves (fig. 1, 1) and the ophthalmic arteries were normal. The hypophysis was embedded in the tumor, but the hypophyseal stem (fig. 1, 5) was visible and free. The abducens nerve could not be identified on either side of the specimen with any degree of certainty. The internal auditory meatuses on both sides (fig. 1, 6) were normal, as were the seventh, eighth, ninth, tenth and eleventh cranial nerves.



Fig. 1.—View at the base of the skull, from within the cavity of the skull; 1, optic nerves; 2, oculomotor and trochlear nerves on the left side; 3, oculomotor nerve on the right side; 4, planum sphenoidale; 5, stem of the hypophysis; 6, internal auditory meatus of the petrous bones; 7, trochlear nerves; 8, tips of the petrous bones; 9, trigeminal nerve on the right side; 10, abducens nerves; 11, trigeminal nerve on the left side; 12, cerebellar artery; 13, area of the cavernous sinus; 14, margin of the tumor.

The floor of the sphenoid sinus on both sides was infiltrated by the tumor. The right sphenoid sinus was almost entirely filled with tumor, while the left was only partially occupied. The roof of the epipharynx (fig. 2) was completely filled with necrotic and hemorrhagic tumor tissue. A large recent blood clot was adherent to the left wall of the nasopharynx, and the mucous membrane was entirely destroyed, whereas the right side was thickened and only partially necrotic.

On removal of the tumor in the epipharynx, marked erosion of the bony roof of the structure was noted. The tumor had extended far into the tips of the petrous

pyramids, which form the lateral portion of the roof, destroying them. The left internal carotid artery (fig. 2, 3), just below its entrance into the temporal bone, showed a circumscribed aneurysmal dilatation (fig. 2, 2), which had perforated on its medial aspect into the tumor (fig. 2, 1). This was the source of the final fatal nasopharyngeal hemorrhage. Although the base of the skull was extensively involved by tumor, the jugular bulb and internal jugular vein were unaffected. The aneurysmal dilatation of the left internal carotid artery was observed to be compressing the glossopharyngeal nerve as it emerged from the skull.

The retropharyngeal gland and the deep cervical glands on the left side were enlarged and firm and, like the internal pterygoid muscle, contained tumor tissue. There were also several arteriosclerotic plaques in the external carotid artery. After

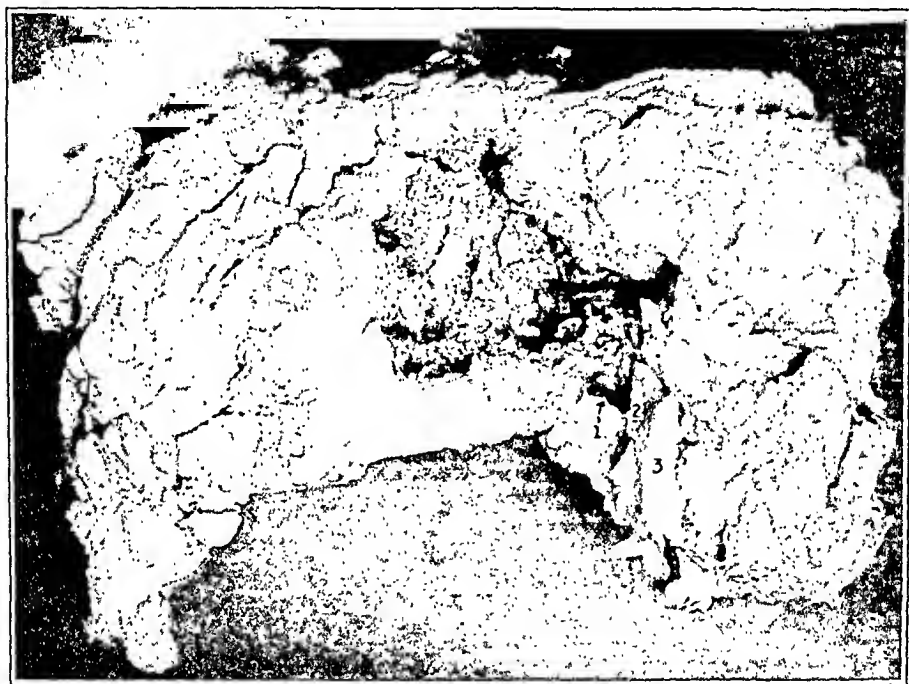


Fig. 2.—View at the roof of the epipharynx. A probe (1) is seen within the internal carotid artery on the left side indicating the perforation in the aneurysmal sac (2); 3 indicates the internal carotid artery.

examination of the intact base of the skull, the tumor was carefully removed and the specimen dissected; the findings were as follows (fig. 3): The sella turcica (fig. 3, 2) was completely destroyed and the hypophysis mechanically displaced but not invaded, as was confirmed microscopically. The tumor covered both of the posterior clinoid processes and invaded the clivus Blumenbachi (fig. 3, 3). Though the surface of this clivus appeared to be roughened, it was not invaded. The tumor extended from both sides of the sella turcica into the cavernous sinus and surrounded both carotid arteries, compressing the latter moderately.

The tumor destroyed the petro-occipital suture, the anterior foramen lacerum, the origin of the greater wing of the left sphenoid body and then extended into the cranial vault (fig. 3, 7). The tumor also destroyed the left gasserian ganglion and all three branches of the left trigeminal nerve. The foramen ovale on the

left side (fig. 3, 6) was normal except along its posterior border, where it was eroded. The foramen spinosum on the left was normal.

Thus, in this case extensive invasion by the tumor was observed, involving the body of the sphenoid bone (with a special predilection for the vascular marrow spaces), the sphenoid sinuses and the tips of the petrous pyramids, with destruction of the outer table of the base of the skull. Intracranial extension of the tumor occurred by way of the petro-occipital suture, the foramen lacerum anterius and the origin of the great wing of the sphenoid body. The tumor did not penetrate the dura, but in its extension grew together with it and thinned it by expansion. The growth of the tumor was almost entirely upward, although there was some lateral spread into the vault of the epipharynx. The tumor grew by eroding the bone and replacing it, except in the sphenoid sinus, where it pushed the mucosal lining ahead of it.

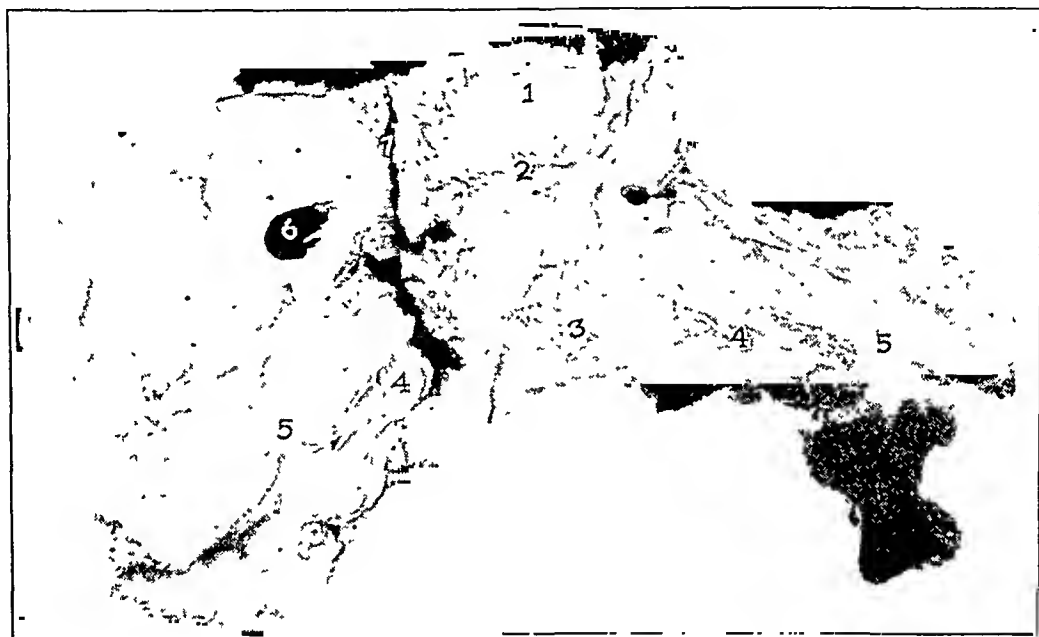


Fig. 3.—View at the base of the skull after the removal of the tumor; 1, planum sphenoidale; 2, area of the sella turcica; 3, clivus Blumenbachii; 4, tips of the petrous bones; 5, superior angles of the petrous bones; 6, foramen ovale on the left side; 7, fissure in the base of the skull produced by invasion of the tumor.

The soft palate evidenced slight infiltration on the left side of the midline. On its nasal surface was a shallow ulcer with a necrotic base and irregular margins. Since this area of the soft palate came into contact with the tumor on the left side of the nasopharynx, it was regarded as another instance of implantation of carcinoma by contact from the nasopharynx to the soft palate. The microscopic section (fig. 4) revealed an area on the nasal surface of the soft palate devoid of epithelium and small groups of tumor cells near the surface. These were present in a small area near the surface. At one place in this area tumor cells were seen in what appeared to be a small lymph vessel (fig. 4*d*). It is believed that this was an example of contact implantation carcinoma similar to that in the case described by Brunner,<sup>10</sup> because the drainage of lymph from the nasopharynx was not directed

10. Brunner, H.: Carcinoma of the Epipharynx: A Peculiar Case, *Arch. Otolaryng.* 29:544 (March) 1939.

to this site and also because the carcinoma cells were observed in small groups solely in the ulcerated area and near the surface. Further study revealed only inflammatory changes in the surrounding submucosa and no evidence that the tumor cells had extended into this area by submucous spread. That there were tumor cells in a lymph vessel in this region might be explained by the fact that implantation cells had been taken into the lymphatics of the submucosa at the site of the ulcerated area. It is quite possible that distant metastases may have come from this area rather than from the original tumor, as distant metastases occur infrequently with



Fig. 4.—Section through the soft palate; *a*, nasal surface of the soft palate without the epithelial layer; *b*, subepithelial infiltration; *c*, tumor cells within the connective tissue; *d*, tumor cells within a lymph vessel.

carcinoma of the nasopharynx. The tongue and esophagus showed no evidence of gross pathologic change. In the larynx, the left ventricle of Morgagni consisted of a large opening with a considerable recess upward. The right ventricle was much smaller and narrower.

#### COMMENT

Although classic symptoms and findings of nasopharyngeal carcinoma, consisting of headaches, nasal hemorrhage, tinnitus, conduction deafness, paralysis of the abducens nerve, diplopia, neuralgia and later

swelling of the cervical glands, were present in the patient who is made the subject of this study, the diagnosis was not made until late, because a tumor was not seen projecting into the nasopharynx. The neurologic diagnoses were vague. Roentgenograms were reported as showing no definite pathologic change, in spite of marked destruction of bone and intracranial invasion later observed at autopsy.

The description of the pathologic process emphasizes the practically hopeless character of the disease when neurologic symptoms and findings are present, even if it is diagnosed correctly. The description of the pathologic process, furthermore, shows the great importance of an exact autopsy in such cases; conclusions even from an exact clinical observation may so often be altered by the results of autopsy. Such was the experience in this case. From pure clinical observation, the tumor apparently originated from the right nasopharyngeal wall and extended into the skull and probably progressed intracranially by way of both superior orbital fissures into the orbits. The autopsy, on the contrary, indicated that the tumor originated in the left nasopharyngeal wall, broke through into the skull by way of the petro-occipital suture and the anterior foramen lacerum at the point of origin of the greater wing of the sphenoid body and, always situated extradurally, invaded the orbits. Contrary to the observations of Brunner,<sup>10</sup> in this case the inner table was perforated. Carcinoma cells were implanted from the tumor in the nasopharynx to an ulcer in the soft palate by contact. This is in accordance with the observation of Brunner. There was also a metastasis to the liver.

It is noteworthy that in our case obvious clinical symptoms referable to the pituitary body were not present, although it was markedly compressed and displaced. A sidelight of interest in this case was the nystagmus obtained by vestibular stimulation in the right eye, which had complete paralysis of the abducens and oculomotor nerves, showing that nystagmus can be elicited with the superior oblique muscle alone.

The importance of this case report is that the study is presented from a complete clinical and pathologic point of view. We believe that knowledge, so far as early diagnosis, prognosis and treatment of this type of case is concerned, will be greatly facilitated by the publication of such combined observations rather than the presentation of large numbers of clinically observed cases.



# Abstracts from Current Literature

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## Ear

THE VALUE OF SULFANILAMIDE IN OTOGENOUS INFECTIONS, WITH SPECIAL REFERENCE TO ITS MASKING EFFECT. JACOB L. MAYBAUM, EUGENE R. SNYDER and LESTER L. COLEMAN, J. A. M. A. 112:2589 (June 24) 1939.

The authors give full credit to sulfanilamide but emphasize their opposition to its indiscriminate use. They state that its use has a tendency to obscure the course of an infection. For acute otitis media it should be used with caution, if at all. It should never be used for suppurative otitis media. They used the drug only for complications of otitic suppurations, such as meningitis, sinus thrombosis and abscess of the brain. Thus far scant attention has been paid to the masking effect, and little reference to this possibility is found in the literature.

Six interesting cases are given, which illustrate the points brought out in the article, which they conclude and summarize as follows:

"The use of sulfanilamide has resulted in a genuine advance in the treatment of certain otogenous infections.

"Exenteration of the otitic focus is of paramount importance.

"Indiscriminate use of the drug may obscure the diagnosis or result in a masked or latent clinical picture of mastoid involvement.

"Under sulfanilamide therapy, the usual clinical course of an otitic complication may be modified."

GORDON, Philadelphia.

SYMPTOMS AND COURSE OF MASTOIDITIS FOLLOWING OTITIS FROM SWIMMING. M. BUCHBAND, Monatschr. f. Ohrenh. 73:332 (May) 1939.

A special type of surgical otitis, produced by infections acquired in swimming, is evaluated by the author. The infection can occur by way of the eustachian tube or by rupture of the drum by some external force, i. e., in diving or in water polo. In seven years, 20 such cases of surgical otitis were observed at the Neumann Otologic Clinic. In 16 of these the former and in 4 the latter path of infection was noted. All varieties of bacilli were found with this type of otitis, but the author cites an epidemic of 21 infections with the Friedländer bacillus. The course in all the cases in no way differed from that of other forms of surgical otitis, except that the death rate was double the normal, ruptured drums especially producing a more fulminant course. It may be reasoned that in these cases the infection meets no adequate resistance by the mucous membrane, because of its rapid onset.

LEDERER, Chicago.

INFLUENCE OF PARATHYROIDECTOMY ON THE HEARING IN CASES OF OTOSCLEROSIS. JUSTO M. ALORRSO and ALBERTO CHIARINO, Acta oto-laryng. 27:123, 1939.

The authors present the effect of parathyroidectomy on the hearing in 19 cases of otosclerosis. After parathyroidectomy or even after ligation of branches of the left inferior thyroid artery they generally observed a more or less marked improvement in hearing. The hearing receded somewhat after the lapse of time but always remained at a higher level than before operation. The improvement of hearing was more marked for the spoken voice than for the whisper. In most of the patients the improvement was more marked on the side operated on. The results were in general better in the patients in whom the gland was extirpated than in those in whom branches of the inferior thyroid artery were ligated. The

best results were obtained in young subjects and in those in whom the otosclerosis had been present for only a few years. Their procedure does not contraindicate the subsequent performance of some sort of "fistulization" operation.

GROVE, Milwaukee.

TREATMENT OF PATIENTS WITH ACUTE SUPPURATIVE OTITIS MEDIA, ESPECIALLY WITH REGARD TO THE VALUE OF SYRINGING WITH ALCOHOL. VIGGO SCHMIDT, *Acta oto-laryng.* **27**:136, 1939.

After discussing the usual care of the ear after early paracentesis the author states that he uses hot compresses for twenty-four hours. He then begins to syringe the ear with a 33 per cent (by volume) solution of alcohol in a 10 to 20 cc. record syringe. This prevents maceration of the skin by pus or by water and by its shrinking action tends to keep open the perforation in the drum and also to open the tube, thereby promoting better drainage. The number of such syringings varies from three to six or even more per twenty-four hours, depending on the severity of the otitis. When syringing with alcohol is begun early after paracentesis pain from the alcohol itself is avoided.

Syringing with alcohol after paracentesis has reduced the number of mastoidectomies from 37.4 per cent to 13.5 per cent, and these figures were arrived at by covering four years in each instance.

Two hundred and eighteen patients so treated were reexamined a year or more after cessation of treatment. In 208 the hearing was normal; 210 had a healed membrana tympani. The response to the functional test was considered normal if the whisper could be heard at 20 meters. Only 2 patients had a moist middle ear. The author believes that all such patients should be hospitalized.

GROVE, Milwaukee.

SURGICAL TREATMENT OF VERTIGO BY OPENING THE EXTERNAL SEMICIRCULAR CANAL AND INJECTING ALCOHOL. W. W. MOLLISON, *Acta oto-laryng.* **27**:222, 1939.

Mollison reports 50 cases of intractable vertigo, in most of which the condition was classified as Ménière's syndrome, in which he exposed the external semicircular canal by simple mastoidectomy. After exposure of the prominence of the external semicircular canal, it was opened by a gouge near its anterior end, and a few minims of absolute alcohol were injected into the vestibule. Only in 2 cases was fluid seen to leak from the opened canal. In 1 case there was transient paralysis of the facial nerve, which cleared up in three weeks.

The attacks of vertigo had continued over one to nine years and were so severe as to incapacitate the patients. Operation was performed only when the hearing of the opposite ear was relatively good and that of the affected ear bad.

Some of the patients had tried various medical treatments and all had taken phenobarbital for several weeks without relief. Some had had a limited water intake and a salt-free diet. Five had had previous mastoidectomies. No patient died as the immediate result of the operation nor did any show signs of infection of the labyrinth. One patient died of nephritis some weeks after the operation.

Seventy-four per cent of the patients described themselves as cured; 10 per cent were not benefited, and the remaining 16 per cent either were improved though not cured or could not be traced.

GROVE, Milwaukee.

## Pharynx

OSTEOMA AT THE BASE OF THE TONGUE. TETSUSABURO HITA and KEN OGITA, *Oto-rhino-laryng.* **11**:1016 (Nov.) 1938.

Review of the literature indicates that osteoma of the base of the tongue is exceedingly rare. In 1913 Monserratt of France reported a case of osteoma. In 1926 Hirsch reported a case of an osteoma the size of a cherry seed in a woman

26 years of age. Hita and Ogita report a case of osteoma in a man 23 years of age. The patient's chief complaint was dysphagia of four months' duration. The tumor was smooth on palpation and located slightly to the right of the median line. The growth was excised with the patient under local anesthesia. It measured 6 by 5 by 4 mm. Hirsh was uncertain whether it was due to embryonic misplacement or metaplasia of the thyroid gland. Histologically Hajek was unable to identify thyroid tissue in the tumor. Glos does not believe in metaplasia of thyroid tissue but advances a theory that osteoma may be found in this region for the same reason that faucial and lingual tonsils occasionally contain bony tissue.

HARA, Los Angeles.

RHINOPHARYNGITIS MUTILANS ON THE ISLAND OF PALAU. MASAO SEKINE and MASAO YOKOO, Oto-rhino-laryng. 12:3 (Jan.) 1939.

The writers report 12 cases of gangosa observed by them on the island of Palau. Travelers in the tropics have long noted natives whose noses have been destroyed and who present characteristic scars on their faces. Some authors attributed the condition to tropical frambesia as a primary cause, and others called it rhinopharyngitis mutilans, or gangosa.

In 1928 Schöbel was able to produce in a Philippine monkey clinical gangosa by introduction of *Treponema pertenue*. The writers report 5 cases in which the actual cause was frambesia tropica. In typical cases the face is greatly distorted by the formation of scars; the external nose, septum and turbinates undergo varying grades of destruction, leaving the passage narrow as the result of contracture. The palpebral fissures are narrowed, and movements of the eyes are impaired. In advanced conditions the hard palate suffers necrosis; teeth fall out, and the soft palate adheres to the posterior and lateral pharyngeal wall. The motility of the tongue is limited, and a characteristic nasal tone of speech develops, the description of which is the Spanish word *gangosa*. In the remaining cases the condition had been called by the Annamese term *ngardik*, the native name for frambesia tropica during the second stage of its development. In the earlier stage the disease is manifest by narrowing of the nasal passages and gradual softening of the gums and nasal septum. Later this process is followed by complete collapse of the external nose and scarring of the skin and muscles on the face. The disease is most often met after middle life, though one of the cases reported was that of a boy 14 years old. The entire island has a native population of 6,022 according to the census of 1934. Besides the 12 cases 2 additional cases of gangosa were known to the writers. The paper contains six photographs of the patients and one table.

HARA, Los Angeles.

A CASE OF FIBROMA OF THE HARD PALATE. TOSHIO KABASHIMA, Oto-rhino-laryng. 12:34 (Jan.) 1939.

Tumor of the hard palate, particularly of a benign type, is rare. Kabashima reports a case of fibroma of the hard palate in a woman 45 years of age who had noticed the growth for five or six years. Recently she had experienced gradual alteration of the voice, and she requested an examination. The tumor was pedunculated and sprang from the center of the hard palate, with a stalk 5 mm. in length. It was removed with a hot snare. It measured 3.3 by 2.3 by 1.2 cm. The surface was smooth, thickest at the center and shaped like a pearl button. Review of the literature regarding benign tumors of the palate in Japan led the author to the conclusion that nearly all kinds of neoplasm arise from the palate, the highest incidence being that of endothelioma. Next in incidence is mixed tumor. Osteoma and myxoma are not reported. Benign tumors of the palate are more common among females, occur more often in the soft than in the hard palate and are most frequently encountered during the fifth and sixth decades.

HARA, Los Angeles.

## Nose

EXTERNAL OPERATIONS ON THE FRONTAL AND ETHMOIDAL SINUSES. NORMAN PATTERSON, J. Laryng. & Otol. **54**:235 (May) 1939.

Operations on the nose are to be avoided when possible, especially as patients who would otherwise make a good recovery are sometimes prevented from doing so by an operative procedure.

After considerable popularity, external operations on the sinuses fell into disrepute for some years because of the frequency of complications. Largely through the efforts of Walter Howarth, the external operation has regained its favor, and attention to details has reduced the incidence of complications. The external operation is not more dangerous than the intranasal, and the scarring, when the incision is properly performed, is negligible.

The frontal and ethmoid areas are so closely associated that the former is almost never opened without also entering some of the cells of the latter. It is possible, on the other hand, to examine the frontal sinus after directing attention to a diseased ethmoid.

In order to secure the most satisfactory cosmetic result compatible with adequate exposure of the diseased areas there are only two regions where the incisions should be made; one is in the neighborhood of the supraorbital ridge; the other is in the cheek. In some cases both incisions, separated by a considerable interval, are employed. The "frontal" incision passes along the supraorbital ridge and is at the center of or just below the hairy eyebrow. The hair should not be shaved, and the incision should not be carried beyond the hairy area. Through this incision all manipulations on the sinus can be carried out, and moreover, the frontonasal region can be explored or entered. The choice between obliteration of the sinus or simple drainage depends on the extent of the pathologic condition encountered.

The "ethmoid" incision begins about  $\frac{3}{4}$  inch (0.6 cm.) below the level of the inner canthus, and it follows the natural sulcus, passing downward and outward into the cheek. It is about an inch (2.5 cm.) in length. The periosteum over the ethmoid area is elevated, and the cells are attacked from before backward. Tearing of the upper end of the incision is prevented by a stitch in the angle of the wound. After all the ethmoid cells are removed the sphenoid sinus can be inspected. By this incision the antrum can be easily entered from the upper part of its nasal wall. If necessary, a large nasoantral opening can be made entirely above the inferior turbinate. Gravitational drainage, in the recumbent position, will occur from such an opening, and if there are any active cilia, they will be effective in providing necessary drainage.

LE JEUNE and BAYON, New Orleans.

OSTEOMYELITIS OF THE SUPERIOR MAXILLA FOLLOWING INTRANASAL OPERATION. SHOJI TAKAMURA, Oto-rhino-laryng. **12**:14 (Jan.) 1939.

Osteomyelitis of the superior maxilla is sometimes met in children but rarely in adults except when of dental origin. Takamura reports the case of a 47 year old fisherman in whom intranasal resection was made for chronic infection of the right maxilla. The evening of the operation swelling over the face, septic temperature, pain and foul discharge from the right nostril developed. Later an abscess developed over the right inner canthus. This was evacuated, but a fistulous tract persisted. The right nostril continued to be filled with a foul discharge. The floor of the nose showed sequestrums. The bony portion of the septum and the lateral wall of the right nostril showed a large perforation. Two months after the operation perforation of the hard and soft palate developed. The right maxilla had undergone complete necrosis, and the nasal cavity was covered with grayish ulcerative membrane. The exciting organism was the staphylococcus. Treatment consisted of both local cleansing and general systemic supportive measures. After an apparent improvement the patient became gradually weakened, and about fifty

days after the onset of the disease hemorrhage from the ulcerated area and death from circulatory failure occurred. Takamura emphasizes the importance of meticulous postoperative care in order to prevent such a complication.

HARA, Los Angeles.

RELATION OF CHRONIC BRONCHITIS AND PARANASAL SINUSITIS. SHIRO NAKAMURA, *Ztschr. f. oto-rhino-laryng.* 45:5 (May) 1939.

During two years (1935 and 1936) the author observed at Keio University Hospital 15 cases of chronic bronchitis associated with paranasal sinusitis. Six patients were in the third and five in the fourth decade; 11 were males, and 4 females. Eighty-seven per cent of them complained of coughing. Others complained of nasal discharge, postnasal drip, nasal obstruction and impairment of the sense of smell. Because of cough and expectoration almost all the patients had consulted internists before being referred to the department of otolaryngology. Nasal examination revealed that 12 had chronic suppurative, and only 3 non-suppurative, sinusitis. Eleven had chronic bronchitis and 3 bronchial asthma. Bronchiectasis developed in 1. Ten were asthenic, 1 phlegmatic and 4 more or less muscular. The author states that the condition was bilateral in nearly all. Physically the patients were highly nervous. He reviews various theories as to the underlying causes of bronchitis and sinusitis, such as deficiency of vitamins, allergic predisposition and low sugar content of the blood, but he advances a theory that bronchitis as a complication of sinusal infection is most frequently observed in the highly neurotic.

HARA, Los Angeles.

### Miscellaneous

ALLERGY IN INFANTS: SIGNIFICANCE OF FIRST ALLERGIC MANIFESTATIONS. N. W. CLEIN, *Northwest Med.* 38:9 (Jan.) 1939.

A series of 100 allergic and 100 nonallergic infants was studied from birth to the age of 4 or 5 years. The feedings, examinations and observations were uniform in all cases.

Of the allergic infants, 71 per cent had allergic parents; of the nonallergic, 12 per cent.

Of the allergic infants, 78 per cent exhibited some allergic symptoms before the fourth month of age, 91 per cent by the end of the first year and 100 per cent by the end of the second year, as follows: rash (eczema), occurring chiefly on the face (85 cases); vomiting (pylorospasm) (24 cases); colic (abdominal pain, gas or diarrhea) (16 cases). Frequently one or more of these symptoms were present at the same time.

Egg yolk should not be added to the diet of allergic infants too early, as many are sensitized through the mothers' milk or inherit the sensitivity.

Taking of a family history, study of the present allergy, elimination and testing are often necessary for a proper solution.

ROBERTSON, Omaha. [*AM. J. DIS. CHILD.*]

STAPHYLOCOCCUS SEPTICEMIA. P. F. STOOKEY and L. A. SCARPELLINO, *South. M. J.* 32:173 (Feb.) 1939.

In a compilation of the records on 117 cases of staphylococcic septicemia from various hospitals the authors found the gross mortality to be 91.4 per cent. Among 28 children less than 18 months of age the mortality was 78 per cent, and among those over 18 months of age it was 94.1 per cent. In 17 patients treated with staphylococcus antitoxin the mortality was 53 per cent.

An early diagnosis of staphylococcic septicemia should be made and treatment carried on with adequate amounts of antitoxin to prevent irreparable damage of tissues.

Although the mortality was markedly lowered by the early administration of staphylococcus antitoxin, the ideal biologic procedure has not been attained.

SCHLUTZ, Chicago. [AM. J. DIS. CHILD.]

A STUDY OF BONE REGENERATION. GUSTAV LEVANDER, Surg., Gynec. & Obst. 67:705, 1938.

The specific osteoblastic theory holds that regeneration of bone may take place from preexisting cells belonging to the different layers; the metaplastic theory maintains that bone may be formed as a result of a process of transformation of nonspecific connective tissue. An essential part of the first theory concerns the predominant role of periosteum. Experimental evidence, however, has shown that it is only the periosteum of the growing skeleton that has the power to stimulate the formation of bone. Also it is known that when fully differentiated hard bone tissue is grafted, new bone is always formed. In a series of rabbits Levander first studied the mode of origin of new bone after transplanting into soft parts hard bone tissue stripped of periosteum. New bone formed from the mesenchymal tissue in the areas surrounding the graft. In his opinion, the specific stimulus necessary for the formation of new bone is brought to the mesenchyme in the form of a substance liberated from the graft and conveyed with the lymph into the surrounding areas. In a second series of experiments alcoholic extract of bone tissue were injected into soft tissues of the abdominal wall as far as possible from any preexisting bone. Cartilage or bone was formed at the seat of injection in 22 per cent of the rabbits. Alcohol alone or alcoholic extracts of other tissues gave negative results in a control series. On the basis of these experiments it is felt that bone regeneration takes place as a result of activation of the nonspecific mesenchymal tissue by some specific bone-forming substance. This supports the heteroplastic theory of the formation of bone and conforms with the views of Spemann with regard to embryonic development.

WARREN C. HUNTER. [ARCH. PATH.]

SOME OBSERVATIONS ON HEADACHE. D. W. C. NORTHFIELD, Brain 61:133, 1938.

Headache was the initial symptom in 36 of 100 unselected cases of verified tumor of the brain. It was not the first symptom in 9 cases of acoustic neurinoma, but it was the initial symptom in 10 of 12 cases of tumor of the posterior fossa. The incidence for gliomas of the cerebral hemispheres was similar to that for cerebral meningiomas. Headache was the initial symptom in more cases of tumor of the temporal than of the frontal lobe. Headache is likely to precede other symptoms in cases in which the tumor, by reason of its location, tends to impede the flow of cerebrospinal fluid through the ventricular system. Of 121 cases, excluding those of pituitary adenoma, frontal headache was absent in only 5 per cent, as compared with 25 per cent of those in which the tumor was infratentorial. Pain in the neck was present in 22 per cent of cases of supratentorial tumor and in 49 per cent of cases of infratentorial tumor. The headache was entirely or predominantly unilateral in 42 cases and did not shift from side to side. In 6 of these cases the tumor was situated approximately in the middle line, but in only 4 cases was the tumor on the side opposite that of the headache.

It is commonly accepted that the headache produced by an intracranial tumor is due to increase in intracranial tension. Of a series of 102 cases of verified tumor of the brain, the pressure exceeded the normal in 63; in 39 it was less than 200 mm. of fluid, and in 16 it was below 100 mm. In many cases in which the pressure was normal or subnormal there was severe headache. In many cases headache is absent although the intracranial pressure is high. These cases demonstrate that the absolute value of the intracranial pressure bears no relation to the presence or absence of headache. Although headache is clearly related to diseases which produce an increase in intracranial pressure, the high pressure in itself is probably not the cause of the pain.

Certain conditions other than intracranial tumor suggest the possibility that headache may be vascular in origin. Patients suffering from an intracranial aneurysm often complain of recurrent headache, which commonly affects one side of the forehead more than the other. This suggests that the gradual stretching of the wall of the artery and the final rupture of the aneurysm may set up a train of afferent stimuli which is interpreted as headache.

During operative procedures, observations were made to determine the relative sensitiveness of various tissues. In the majority of cases the traction necessary to produce pain on stimulation of the dura mater was considerable. The tentorium seemed to be more sensitive than other areas of the dura mater, except that around the middle meningeal arteries; the dura mater lining the vault was the least sensitive. Pressure on or displacement of the internal carotid artery in the vicinity of the anterior clinoid process resulted in pain in or near the homolateral eye in 3 cases, pain in the homolateral temple in 1 case and no sensation in 1 case. In no case did sensation of any kind result from pressure on the pia mater, the brain tissue or the walls of the ventricles. The cortical veins and arteries and the choroid plexus were insensitive to clamping and to endothermy.

The effect of raising the intraventricular pressure was noted in 4 cases. Warm Ringer's solution was injected quickly into the ventricles in the course of ventriculographic examination, before the removal of any cerebrospinal fluid. Headache resulted in 2 cases. In 3 cases of tumor high in the spinal cord Ringer's solution was injected into the cisterna magna. In 1 case, after the injection of only a few cubic centimeters of fluid, the patient complained of severe frontal headache. Twenty cubic centimeters of Ringer's solution injected under the dura mater in the course of cerebellar exploration, probably into the subdural space, has resulted in homolateral occipital headache, which gradually disappeared as the fluid escaped. Compression of the jugular veins for two minutes induced headache in 6 of 9 cases, and in 4 of these the resulting intracranial pressure was not above 200 mm. of water.

In many cases headache was produced by suddenly reducing the intracranial pressure. In 5 cases in which the lateral ventricles were tapped, the sudden escape of fluid was attended by considerable pain.

Headache does not occur during the ventriculographic procedure, whereas it is intense during encephalographic examination.

From study of clinical material and experimental observations it appears that the sudden increase or decrease of pressure, previously normal or abnormal, readily causes headache. Rapid reduction of pressure is perhaps the more conspicuously successful method. The conclusion may be drawn that it is the sudden variation in the intracranial pressure, and not the steady pressure itself, which induces experimental headache.

Histamine phosphate was injected into 14 patients suffering from tumor of the brain, and in 11 cases the headache which occurred was similar in quality and distribution to that produced by the tumor. During the course of cerebral arteriographic examination histamine phosphate was injected into the common carotid artery in 13 patients, resulting in homolateral headache in 6 cases and bilateral headache in the others, the headache being more severe on the homolateral side. The injection of histamine in the internal carotid artery resulted in homolateral headache in all of 5 cases. In the same 5 cases, injections into the external carotid artery did not produce headache. Division of the middle meningeal vessels did not prevent bilateral headache after the intravenous injection of histamine.

The only intracranial tissue other than the dura mater which is sensitive to suitable stimuli is apparently the cerebral blood vessels. It is Northfield's belief that the headache associated with intracranial tumor is due to disturbance of the tension of the walls of the cerebral vessels. It is this disturbance which provides the adequate stimulus for the excitation of pain.

OTITIC ZONA, ASSOCIATED WITH ZONA OF THE TRIGEMINAL, GLOSSOPHARYNGEAL AND SUPERIOR LARYNGEAL NERVES. BALDENWECK and DEGORCE, *Rev. d'oto-neuro-opht.* **17:29** (Jan.) 1939.

Baldenweck and Degorce report the observation of a case of otitic zona, with involvement of the right fifth, ninth and tenth cranial nerves. Both the cochlear and the vestibular division of the eighth nerve were involved. The eruption appeared on both sides of the epiglottis. The question is raised whether the upper cervical plexus was involved. Despite the occurrence of the eruption also in the submaxillary and retroauricular regions, it is suggested that this may have been due to involvement of the cervical branch of the seventh and of the recurrent sensory branches of the fifth nerve, respectively. Furthermore, the opinion is expressed that it is more logical to believe that the seat of the lesion was in the bulbar nuclei rather than that a number of ganglions were involved. Support for this opinion is supplied by the facts that the paralysis was limited to the upper branch of the facial nerve and that the left cochlear and vestibular nerves also were affected to some degree.

DENNIS, San Diego, Calif. [ARCH. NEUROL. & PSYCHIAT.]

HISTOLOGIC CHANGES IN THE EAR, NASOPHARYNX, LARYNX AND TRACHEA PRODUCED BY SPLENECTOMY. G. ZANZUCCHI, *Arch. ital. di otol.* **51:38** (Jan.) 1939.

Numerous investigations of the effect of splenectomy on other organs have been done, and it has been shown that removal of the spleen produces in the organism no lasting damage, because other organs assume a vicarious function. The immediate effects are reactions in the blood and in the organism as a whole: the appearance of immature red cells in the peripheral circulation, leukocytosis and congestion of the liver, kidneys, bone marrow and lungs. Busacca observed in splenectomized dogs slight hyperplasia of the tonsillar tissue two months after the operation followed by a marked involution at the fifth month. Zanzucchi removed the spleen in 22 adult rabbits, killed them in groups of 5 or 6 at intervals of one, two, four and eight weeks after the operation and then investigated the histologic changes in the ear and upper air passages. In the noses of all of the first and second groups congestion and hemorrhages were found in the submucosa; in half of them similar changes were found in the pharynx, larynx and trachea and in their associated lymph glands; in the medulla of the bone of the internal ear congestion was noted in half the cases. In the third group the changes were less marked, and in the fourth group the changes were even less or were absent. The observations agree with those of investigators concerned with alterations in other organs and tissues.

DENNIS, San Diego, Calif.

ROLLING MOVEMENTS IN PIGEONS. E. HUIZINGA, *Arch. f. d. ges. Physiol.* **240:713**, 1938.

Huizinga studied the rotation of the head appearing in pigeons several days after unilateral labyrinthectomy. If one labyrinth is extirpated first and the second labyrinth after several months, the symptoms of deficiency are much more marked than after the first labyrinthectomy; rotation of the head appears within twelve hours. These phenomena suggest the importance of the compensatory process in the vestibular nuclei in the genesis of the rotation. Rolling movements appeared in 1 animal. They are due to the marked rotation of the head, which finds no support.

SPIEGEL, Philadelphia. [ARCH. NEUROL. & PSYCHIAT.]

ACOUSTIC HALLUCINATIONS AS THE PRODROMAL SYMPTOM OF SCHIZOPHRENIA. G. J. VLAVIANOS, *Monatschr. f. Ohrenh.* **73:68** (Jan.) 1939.

A man 44 years old suddenly noticed tinnitus in both ears and heard voices talking to him. Pathologic changes in the ear were not observed. The author believes that the tinnitus was not produced by an otic disease but may be the first symptom of schizophrenia.

LEDERER, Chicago.



TREATMENT WITH VITAMINS IN OTOLARYNGOLOGY. A. EROEDI, *Monatschr. f. Ohrenh.* **73**:95 (Feb.) 1939.

The efficiency of vitamins in otolaryngologic practice is briefly summarized. The writer stresses the importance of vitamin C, which is supposedly a specific remedy for all acute ulcerations within the mouth, particularly Plaut-Vincent's angina.

LEDERER, Chicago.

SALIVARY CALCULI AND SIMULTANEOUS INFLAMMATION OF THE TESTICLES. A. BARUCHOFF, *Monatschr. f. Ohrenh.* **73**:117 (Feb.) 1939.

The writer describes a case of a calculus within Wharton's duct, combined with an inflammation of the testicle on the same side. After spontaneous expulsion of the stone the inflammation of the testicle subsided.

LEDERER, Chicago.

HEMORRHAGES OF THE ESOPHAGUS PRODUCED BY FOREIGN BODIES OFFERING DIAGNOSTIC DIFFICULTIES. J. DANIELEWICZ, *Monatschr. f. Ohrenh.* **73**:121 (Feb.) 1939.

A woman swallowed a piece of glass, after which she experienced difficulty in swallowing and expectoration of blood. The foreign body was found within the isthmus of the esophagus and was removed. Recovery followed. In another instance a woman had swallowed a bone six weeks before coming under observation. During this time she had pain on swallowing, general malaise, melena and bloody expectoration. Roentgen findings were entirely negative. During her stay in the hospital two hemorrhages occurred. A subsequent roentgen examination revealed stasis of the barium paste at the level of the jugular vein. A bone was found at the isthmus of the esophagus by means of the esophagoscope and was removed. Recovery was uneventful.

LEDERER, Chicago.

THE IMPORTANCE OF THE PSYCHOLOGIC FUNCTION IN THE SYNDROME OF STAMMERING. L. PATZAY-LIEBERMANN, *Pract. oto-rhino-laryng.* **2**:54 (Feb.) 1939.

The author discusses the results of an investigation into psychologic effects on stammering. He believes that single elements of the syndrome can be understood only if considered from a "global" standpoint. He analyzes the concomitant movements of stammerers from the standpoint of their expressional content and concludes that in the moment of stammering the entire function of expression is submitted to a dispersion and those parts of the expression which cannot be uttered verbally appear as mimic (motor) symptoms. He further analyzes the psychologic conditions which favor the occurrence of stammering.

PERSKY, Philadelphia.

TREATMENT OF CONGENITAL ATRESIA OF THE NASOLACRIMAL DUCT. S. LARSSON, *Acta ophth.* **16**:271, 1938.

The nasolacrimal duct may be longer than the bony canal containing it. In such cases it continues below the orifice of the bony canal, its medial wall being covered by nasal mucous membrane. Its normal opening may form a window on the medial wall above its end. For this reason there are certain patients with congenital atresia of the lacrimal duct who cannot be successfully treated by probing, for the probe passes to the floor of the nasal fossa without producing a perforation medially. In 2 such instances the author has removed the tip of the inferior turbinate and incised the mucosa against a probe which had previously been introduced in the usual way.

PERKINS, New York. [ARCH. OPHTH.]

# Society Transactions

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## MASSACHUSETTS EYE AND EAR INFIRMARY

*Cases Selected from the Regular Weekly Clinical Meetings from January 1938  
to January 1939*

EDITED BY R. L. GOODALE, M.D., BOSTON

### Toti-Mosher Operation. DR. G. H. POIRIER.

An automobile salesman came to me with a history of hospitalization for eight weeks with a fractured skull and an infected scalp incurred in an airplane accident. On his discharge from the hospital he had slight lacrimation of the left eye. He consulted an ophthalmologist, who probed the lacrimal apparatus, causing him a good deal of pain. During the following year he consulted a dozen or more ophthalmologists. He had a "colored fluid" injected through the duct, most of which came into the nose and throat.

On examination he had the typical membrane over the tear sac. Pressure caused pus to exude from the upper and the lower canaliculus. Roentgenograms made after injection of iodized poppyseed oil into the sac showed that the oil went through the canaliculus into the sac and then onto the floor of the antrum. That is, it went through the various passages made by the operators. Normally it should have gone through the nasolacrimal duct toward the floor of the nose.

A Toti-Mosher operation was done six weeks before the date of this report. Since then the patient has been entirely free from pus and tearing and has no symptoms referable to the antrum. The point which I wish to bring out in connection with this case is that the injection of iodized poppyseed oil and the roentgenograms were a great help in tracing the symptoms. I think most of the ophthalmologists were led astray by the colored fluid going into the nose and throat. The antrum was not infected.

### DISCUSSION

DR. W. B. HOOVER: I think this is a unique case. I do not think that anybody has demonstrated a connection with the antrum before. If the stricture is near the canaliculus of the sac, does Dr. Poirier do a Toti-Mosher operation and then put in a device between the sac and the canaliculus?

DR. G. H. POIRIER: There is a good reason for doing a Toti-Mosher operation if there is stenosis of the lacrimal duct. When dealing with a partly or completely blocked canaliculus, one can do a Toti-Mosher operation, and in addition to that one can then slit the canaliculus as far as its juncture with the anterior wall of the sac, making one big hole which will do the work without any permanent style or other instrument. Possibly one might have to dilate that large slit a few times for a few weeks after the operation, but it works well.

DR. H. P. MOSHER: This was, evidently, a case of fracture.

DR. G. H. POIRIER: There is no question in my mind that probing is often a cause of dacrocystitis.

**Bilateral Aerocele and Abscess of the Neck.** DR. C. T. PORTER and DR. W. J. WHERRY, with Roentgenologic Report by Dr. A. S. MACMILLAN.

DR. W. J. WHERRY: A 58 year old man was first seen in the outpatient department in September 1937, complaining of hoarseness for the previous four

months. The left vocal cord could not be seen by indirect laryngoscopic examination, because of a cauliflower-like, reddish gray, lobulated tumor in the left ventricular region. There was no limitation of motion of the right cord. The differential diagnosis at this time was syphilis, malignant disease or tuberculosis. The patient was admitted to the hospital for biopsy. The report was chronic inflammation. Roentgenograms of the chest showed no pathologic change. The Hinton test indicated the presence of syphilis. During the next six months the size of the tumor remained about the same, and on two occasions biopsy was again performed to determine the question of malignant disease, syphilis or tuberculosis. In spite of persistent negative reports, the staff of the tumor clinic felt that the growth must be malignant and instituted roentgen treatment.

Nine months after the first visit, roentgenograms showed air spaces on each side of the hypopharynx, which continued to increase, to an extent sufficient to make respiration difficult. Because of the bilateral aerocoeles and an anterior swelling of the neck due to perichondritis of the thyroid cartilage resulting from the roentgen treatment, tracheotomy was necessary.

Three months later, the anterior swelling of the neck had markedly increased and had become fluctuant. Dr. Poirier made a midline incision in the neck extending from the hyoid bone to the tracheotomy wound and obtained pus. The exploring finger could be passed easily on the left side of the larynx to the esophagus and could touch the cervical vertebra. On the right side the finger could not pass deeper than the larynx. A rubber drain was inserted for drainage.

The patient returned to the hospital three months later with a persistent draining fistula in the anterior part of the neck.

Two days ago, a midline incision was again made, and the exploring finger again passed on the left side as far as the vertebra. There was also a fistulous tract between the hypopharynx and the neck. No pus was encountered at this time. Roentgenograms have been taken from time to time to observe the progress.

DR. A. S. MACMILLAN: The first roentgenogram of the neck taken in this hospital, about one year after the patient first came in, shows the two large air spaces on either side of the spine. Then an abscess developed and one can see the marked increase in density in the pretracheal and laryngeal region. That abscess was drained, and the large air cells seemed to be much larger than they were before. One can see where a tracheotomy has been done. Now today, the neck shows marked swelling in front of the larynx.

DR. W. J. WHERRY: Dr. A. O. Freedman, of Montreal, gave a plausible explanation of this condition (*Diseases of the Ventricle of Morgagni, with Special Reference to Pyocoele of a Congenital Air Sac of the Ventricle*, *ARCH. OTOLARYNG.* 28:329 [Sept.] 1938). The sacculus, the lining of which contains numerous mucous and lymphoid glands, has been called the "oil can" of the larynx.

In the orang-utan and the howling monkey a large air sac connects with the ventricle of the larynx. The condition in the case just presented is comparable to this.

Dr. Freedman gave a plausible explanation for the persistent biopsy reports of chronic inflammation in this type of case. The aerocoeles of the neck become infected, fill up and spill their contents continuously over the vocal cords, setting up a chronic inflammatory condition, which in time can produce a rather large lesion.

#### DISCUSSION

DR. H. P. MOSHER: What was the end result in the case?

DR. W. J. WHERRY: The patient was discharged from the hospital and has a normal voice.

DR. H. P. MOSHER: That certainly is a fortunate outcome.

**Acute Pansinusitis on the Right, Meningitis, Septicemia, Extradural Abscess and Abscess of the Frontal Lobe.** DR. C. T. PORTER, DR. P. MYSEL and DR. W. J. WHERRY, with Roentgenologic Reports by DR. A. S. MACMILLAN.

DR. W. J. WHERRY: A 21 year old boy was first seen in the emergency ward, on March 5, 1939. He had had an acute head cold for two weeks. Three days before admission he had had a severe shaking chill followed by persistent frontal headache on the right, nausea and vomiting.

On admission he was semicomatose, and he had partial paralysis of the left side of his face and left arm and complete paralysis of the left leg, stiffness of the neck and a positive Kernig sign. Lumbar puncture revealed an initial pressure of 220, with 453 cells, of which 86 per cent were polymorphonuclear leukocytes. The diagnosis was acute bilateral pansinusitis with extradural abscess and meningitis.

DR. A. S. MACMILLAN: A roentgenogram of the patient showed pansinusitis with both frontal sinuses, both ethmoid sinuses and both antrums full of pus. This is a picture of pansinusitis in the acute stage at the end of the first week. The lateral view, however, showed the sphenoid sinus perfectly clear and the floor of the frontal sinus dense. The frontal sinus, deep as it was and thin as the bone was around it, should have been as black as the sphenoid. The outline of a large diploetic vein could be made out in the skull. Such veins are regarded with suspicion, because when one observes pus in the frontal sinuses some of them run into the margin of the sinus itself.

DR. W. J. WHERRY: Because of the severity of the infection, the boy was operated on immediately. A bilateral radical frontal operation was done by Dr. Mysel. On removing the posterior wall of the right frontal sinus, an extradural abscess containing about 2 ounces (7.4 cc.) of pus was uncovered. The posterior wall of the left frontal sinus was uncovered, but there the dura was normal.

The next day the blood culture was reported to contain the beta hemolytic streptococcus, and sulfanilamide therapy was immediately instituted. Two days later, because of the herniation of the right frontal lobe through the bony defect, that lobe was probed for abscess of the brain. Nothing was found. For the next eleven days the patient's condition remained stationary. Because of the paralysis of the left side, the neurologic consultants felt that we were dealing with an abscess of the brain, high in the right frontal lobe.

On March 18 Dr. Mysel enlarged the bony defect over the right frontal lobe, removing the frontal bone upward for 3 inches (7.6 cm.). On probing on the upper portion of the exposed area a large abscess of the brain was tapped. A portion of the cortex over the abscess was removed and a Mosher wire basket inserted, the apex of which almost reached the bottom of the abscess. Since that time the patient has shown gradual improvement. The spinal fluid pressure has stayed around 260, and the cell count has dropped to 2. He does not have stiffness of the neck or paralysis, and, because of the consistently negative blood cultures, administration of sulfanilamide has been stopped.

On April 1 the right frontal lobe was probed inferiorly for a daughter abscess. Nothing was found.

For the last ten days the patient has shown definite improvement clinically, until yesterday, when he became irritable and complained of severe frontal headache. Lumbar puncture was done, and the initial pressure was 480, with 25 cells, of which 15 were polymorphonuclear leukocytes. At present he is listless, although easily aroused, and responds readily to questions.

#### DISCUSSION

DR. H. P. MOSHER: It certainly looks as if the treatment in this case is not over. The basket drain has to be kept clean and curetted. Of course, it can, as

in this case, close over at the end. It did close over, but in this case lies in line with all cases of abscess of the brain; after a long delay in healing, it looks like another case of abscess of the brain.

DR. GORDON BERRY: Two or 3 patients have been treated with sulfanilamide. The patients got better; the administration of sulfanilamide was stopped, and then the patients returned to the hospital.

DR. H. P. MOSHER: My associates and I have had the same experience. Patients sent out apparently better are coming back with meningitis.

**Pansinusitis on the Right and Extradural Abscess.** DR. H. G. TOBEY and DR. F. M. WATTLES, with a Roentgenologic Report by DR. A. S. MACMILLAN.

DR. F. M. WATTLES: A man aged 39 was admitted to the hospital on January 17 with a history of pain over the right temporal region with a stopped-up nose and a purulent discharge from the right side of the nose. He had been seen two weeks after the onset of the infection in the clinic, at which time a roentgenogram of the sinuses was taken. This was two weeks before his admission to the ward.

DR. A. S. MACMILLAN: Roentgenograms showed pansinusitis on the right side. The outline of the frontal sinus on the left side was not clear. There was pus in the right antrum and the right frontal sinus, too. Two small areas of increased density represented little exostoses on the inner table of the skull and on the posterior and anterior walls of the frontal sinus. But when the patient came in at the end of two weeks from the onset of the stuffed nose, he had definite pansinusitis on the right side.

DR. F. M. WATTLES: Previous to admission, he had had three washes of the antrum on the right side. The symptoms decreased markedly, but he complained of slight right frontal headache, and on January 17 it was thought that because he had not improved sufficiently he should be sent to the ward for further treatment.

DR. A. S. MACMILLAN: On the morning after the patient was admitted, because of what had happened since the first roentgenogram was taken, my associates and I looked carefully into the right frontal sinus again. The outline of that sinus was about the same as before, but there was an area of exostosis that was much clearer than before. Looking back, I think that there was decalcification of the posterior wall of the frontal sinus where the little osteoma was situated.

DR. F. M. WATTLES: One-half hour after the roentgenograms were taken the patient had a sudden generalized convulsion, which made him bite his tongue. He became cyanotic. He had four more convulsions of less severity in succession. The neurologic staff saw the patient and found no localizing signs at all, and they suggested either an epileptic attack of syphilis of the central nervous system or an abscess of the brain from the pansinusitis on the right.

The next morning the patient felt well, but because of the convulsion Dr. Tobey and Dr. Poirier decided to investigate the right frontal sinus. The leukocyte count on admission was 13,000, with 80 per cent polymorphonuclears. The chest was perfectly clear up to the day of operation.

On January 20, three days after admission, the patient was operated on by Dr. Poirier. At this time, with the patient under ether, a radical operation on the right antrum was done. There were thick creamy pus and necrotic bone in the antrum. Then an external orbital incision was made from the outer limit of the right frontal sinus down to the inner canthus. The lacrimal sac was dissected back from its bed, and the ethmoid labyrinth was exenterated. The front wall of the frontal sinus was completely removed, and in doing this it was found that this sinus was full of the same thick yellowish pus. When the sinus was completely exposed a large area, about the size of a five cent piece, was found in its superior lateral angle. It was covered with granulation tissue, with a small cone of dura easily seen in the middle of it. The granulations were sponged off. No

break was found in the dura. In removing the posterior wall of the frontal sinus much more bone was found to be soft and necrotic. An iodoform pack was put in. Two sutures were placed at the end of the incision at the inner canthus of the eye. The upper part of the wound was left open. The patient was sent to the ward with pressure dressing.

Thirty minutes after the operation he had a severe chill. A blood culture was taken at this time for typing for immunotransfusion. This was later found to be negative. The patient was well during the afternoon, and the next morning, when he was seen at 7 o'clock, he had no complaints. At 10 o'clock, when Dr. Poirier visited him, the patient had a pain in the right side of the chest.

Examination showed a few rales at the base of the right lung and a pleural rub. At this time a roentgenogram showed marked pneumonitis on both sides. The patient during the day was kept as quiet as possible with morphine. He took fluids well.

Dr. Means, of the medical service of the Massachusetts General Hospital, saw the patient and suggested merely supportive treatment and close watching. During the night, as the patient's breathing was more labored, he was placed in an oxygen tent. His color remained good. The next morning the breathing was more labored. The temperature was 103 F. The pulse rate was around 120 and the respiratory rate 35. A leukocyte count at the time showed 16,000 cells, with 82 per cent polymorphonuclears. Dr. Means again saw the patient and discussed with Dr. Lyons the feasibility of sulfanilamide treatment in view of the recovery of *Staphylococcus albus* from the pus.

Before the operation the patient had a spinal fluid pressure of 210. The differential blood count showed 8 polymorphonuclears and 8 lymphocytes.

Two days after operation the condition was much worse. The patient was comatose. Examination showed that the process had extended almost completely over the right side of the chest and affected most of the left lung. At 2:30 he died. Permission for postmortem examination was not obtained.

DR. A. S. MACMILLAN: Postmortem roentgenograms showed complete consolidation of the right lung and behind the heart on the left side. Plates of the skull showed nothing remarkable.

DR. F. M. WATTLES: Cultures of the spinal fluid and two blood cultures were entirely negative. Hinton and Wassermann tests were reported negative.

#### DISCUSSION

DR. G. H. POIRIER: After operation the patient improved slightly, and my associates and I were never able to obtain any neurologic signs at all except for the spinal fluid findings. The cause of death was pneumonia.

DR. H. P. MOSHER: This case was brilliantly managed from the diagnostic and operative standpoint. I once made the remark that an exploration immediately or within a reasonable time for diagnosis was in order. It looks like an instance of postoperative pneumonia. Why it does not occur more often is a mystery to me.

**Acute Suppurative Otitis Media on the Left, with Mastoiditis and Osteomyelitis of the Skull.** DR. G. H. POIRIER, DR. L. E. WHITE, DR. R. L. GOODALE, DR. P. MYSEL, DR. B. E. LOVESEY, DR. J. M. CONVERSE and DR. I. H. BLAISDELL, with Roentgenologic Report by DR. A. S. MACMILLAN.

DR. B. E. LOVESEY: A boy 15 years of age was first admitted to the hospital on Aug. 15, 1938, with a history of acute otitis media of five days' duration. During that time his temperature had ranged between 101 and 104 F. At the time of admission his temperature was 105 F. Cultures of the ear revealed a hemolytic streptococcus, and the patient was given adequate doses of sulfanilamide.

After this, his temperature subsided somewhat, and on August 25, ten days after admission, simple mastoidectomy was done on the right by Dr. R. L.

Goodale and Dr. J. M. Converse, as all blood cultures were positive, although the sulfanilamide content of the blood was 28 mg. per hundred cubic centimeters. At operation a large perisinal abscess was found, and the sinus itself was seen to be thickened and covered with necrotic granulations. The sinus was opened, and free bleeding from both ends was obtained. At this time also the patient presented symptoms of pulmonary infarction, which subsequently went on to the formation of an abscess which was drained surgically.

For a time after operation the patient responded fairly well, and then again he began to show a septic temperature. On September 22, the mastoidectomy wound was revised, and the internal jugular vein was ligated. During the next week the septicemia continued, and on September 29 the jugular bulb was explored. At this time there appeared also a reddened area on the right wrist, which was diagnosed by the surgical consultants as osteomyelitic. It was decided, however, that operative intervention for the osteomyelitis was inadvisable. During this period the patient had received large doses of sulfanilamide and had had a total of twenty-five blood transfusions.

He began to convalesce and was discharged from the hospital on October 20.

For the next two months he did well at home, but on December 19 he complained of postaural pain on the right side in the region of the operative defect, and for two weeks there had been a gradually increasing postaural swelling. He was readmitted to the hospital and roentgenograms were taken.

DR. A. S. MACMILLAN: They showed the defect of bone due to the mastoidectomy and an area of osteomyelitis posterior to it, with a large sequestrum at this point. An anterior-posterior view showed the same sequestrum in the occipital bone, within the area of osteomyelitis.

DR. B. E. LOVESEY: On December 22, a large area of osteomyelitic bone was removed by Drs. Mysel, Quincy and Drooker from the occiput, posterior to the mastoid defect, but the patient's condition on the operating table became so critical that the operator was forced to terminate the operation before its completion. Again the patient received several transfusions and apparently began to convalesce. However, during the last week of January 1939 he began to have repeated febrile attacks and complained occasionally of headache. There was considerable tenderness about the operative wound. Roentgenograms were again taken on February 10 and showed extension of the osteomyelitis.

DR. A. S. MACMILLAN: An area of osteomyelitis apparently extended up a region which the films taken before showed to be perfectly solid and in which they showed the blood vessels to be of normal size. In the later roentgenogram were shown blood vessels becoming more prominent and bone becoming definitely soft.

DR. B. E. LOVESEY: The following day further osteomyelitic bone was removed by Drs. Poirier and White, and an area of normal dura  $3\frac{1}{8}$  by  $3\frac{5}{8}$  inches (8 by 9 cm.) was uncovered. The patient withstood this operation fairly well but again received another transfusion, making the total number of blood transfusions which he had had thirty-one.

Follow-up roentgenograms taken on March 3 showed no further extension of the osteomyelitis.

DR. A. S. MACMILLAN: They showed the extensive removal of bone extending from the original site of operation to the posterior parietal and the occipital bone.

DR. B. E. LOVESEY: The patient began to improve, and the temperature returned to normal. However, on March 11, the right radius, which had apparently been quiescent for several months, flared up and become acutely tender and swollen. The following day the surgical consultant, Dr. Sarris, of the Massachusetts General Hospital, removed sequestrums and curetted the cavity. Since that time the patient's course has been uneventful, and all wounds are healing well. It might be of interest to know that a total of 5,198 grains (337 Gm.) of sulfanilamide were used in the treatment.

## DISCUSSION

DR. H. P. MOSHER: It has been a long time since osteomyelitis has been associated with mastoidectomy. I can remember in the dim distant past 2 or 3 such cases. The second point, even more clearly evident now than before, is that, the condition of the patient permitting it, one should do as extensive an operation for osteomyelitis of the mastoid as one would for that of the frontal bone.

EDITOR'S NOTE: The patient had an uneventful course until Sept. 30, 1939, when he complained again of pain in the right elbow and forearm. He was referred to the osteomyelitis clinic of the Massachusetts General Hospital. A roentgenogram of the forearm and elbow showed findings consistent with infectious arthritis. The patient was given sulfanilamide, 15 grains (0.97 Gm.) daily, on the advice of Dr. Champ Lyons of the Massachusetts General Hospital. Under this treatment he has shown continued improvement, so that on December 6 sulfanilamide was omitted.

**Chronic Suppurative Otitis Media on the Right, with Complications.**

DR. H. P. CAHILL, DR. G. B. FRED and DR. J. C. DROOKER.

DR. J. C. DROOKER: A 14 year old girl came to this hospital on October 11. The history went back to three weeks before, when she had a severe head cold. Ten days before her admission to the hospital she had severe pain in the right ear, requiring her to stay in bed. Four days before admission the right ear began to discharge. The same day she had several attacks of chills and non-projectile vomiting. Three days before admission she had an elevated temperature and vomited again. On admission, the patient had a temperature of 102 F. There were stiffness of the neck, bilateral Kernig signs and a positive Babinski sign. An immediate lumbar puncture showed a positive reaction to the Tobey-Ayer test on the right side, with 2,960 cells in the spinal fluid, 60 per cent of which were polymorphonuclears. The white blood cell count was 25,400, with 78 per cent polymorphonuclears. Examination showed a posterior perforation in the right membrana tympani. Little pus was seen. The patient had a periodic facial twitch every twenty-five seconds. The mother said it was a habit.

The past history revealed that at the age of 7 the patient had struck the right ear when she fell on a picket fence. A discharge from the ear followed this accident for a year and then subsided spontaneously.

Roentgenograms showed definite destruction of the right mastoid with no involvement of the petrous pyramid on the affected side.

A routine postaural incision was made with the patient under nitrogen monoxide-oxygen anesthesia, and when the cortex was uncovered thick yellow pus was obtained. The lateral sinus was uncovered and appeared to be collapsed. A thick fibrinous plastic exudate was found covering the cerebellar dura and the lateral sinus and extending further back, toward the occiput. For this reason a counterincision was made and the bone removed for  $1\frac{1}{2}$  inches (3.8 cm.) behind the lateral sinus. As far as the bone was removed the fibrinous exudate was present. The lateral sinus was packed off and incised and found to contain no blood when the packs were removed. A cannula was inserted in the upper end, toward the torcular Herophili, and free bleeding was obtained. There was no free bleeding from the lower end. The patient was returned to the ward and seemed to be getting along well.

A lumbar puncture was done the next day. The spinal fluid cell count was 540, with 44 per cent polymorphonuclear leukocytes.

On October 18, that is, seven days after operation, the patient complained of severe pain, not only on the diseased side but in the left ear as well. The left ear was examined and found to be perfectly normal. The stiffness of the neck by this time had subsided. The Kernig sign had disappeared. However, the



patient complained of extremely severe pain in the right side of the head and neck. Certain other signs had appeared: nystagmus to the opposite side and past pointing both sides, more on the right.

On October 19 the patient's pulse rate dropped to 70. A lumbar puncture on this day showed the presence of 67 per cent lymphocytes and an initial pressure of 100. Dr. James B. Ayer, of the neurologic service, saw the patient in consultation.

On the basis of the slow pulse, severe headache, increased blurring of the optic disks and condition of the spinal fluid as described, the decision was that the patient probably had a cerebellar abscess on the right. She was brought to the operating room. She had some respiratory distress and had Cheyne-Stokes breathing.

With the patient under nitrogen monoxide, oxygen and ether anesthesia, the dressing was taken down. It was noted that when the granulations in the mastoidectomy wound were cleaned the blood became black. The patient was found not to be breathing, and immediately one of the operators started to administer artificial respiration before the operation started.

The operation, which was done in two and one-half minutes, consisted of incising the medial wall of the right lateral sinus and inserting a Cushing needle to a depth of 4 cm. in a posterior-superior direction. Pus was immediately obtained. Because the patient was not breathing it was decided to remove all the pus present in the abscess, which amounted to 12 cc. The smear showed a hemolytic streptococcus. Subsequent cultures were negative. A rubber tube was inserted into the depth of the abscess, and after three minutes of artificial respiration the patient was breathing again.

That afternoon she had Cheyne-Stokes respiration again. In the evening her condition was poor; her color was poor and her respirations shallow. The drain was removed, and we looked for more walled-off pus. The finger was inserted for a depth of 3.5 cm., striking the cerebellar tentorium anteriorly. A large Mosher drain was inserted in the tract through the cerebral cortex and sutured in situ without anesthesia. The patient's condition improved somewhat and on the next day a small amount of pus drained through the Mosher basket. On the following day the respirations became so poor that it was decided to put the patient in a respirator. She was in the respirator for five days. For the next four days there was little drainage through the Mosher basket. The patient's condition was critical. Dr. Fred decided to remove the drain and put in a rubber tube. Another pocket was found, containing 2 cc. of pus. The condition now is rather poor, and she is kept breathing in the respirator. It is impossible for her to breathe when out of the respirator.

#### DISCUSSION

DR. L. A. SCHALL: This is another case of disastrous cerebellar abscess.

DR. G. B. FRED: At the time of operation we found no capsule, and the question in my mind at that time was whether to put in a drain or merely to let all the pus out and then withdraw the needle. I did put in a small rubber drain. The problem now is to get her to breathe, and the thing in the back of my mind is whether she could stand any more removal of bone from the outer edge of the foramen magnum so as to get operating space toward the medulla. The question is whether the pressure will go down with drainage and whether the medulla will function again.

DR. H. P. MOSHER: This is the first time it has been necessary to use a respirator in connection with abscess of the brain in this hospital.

## Book Reviews

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**Medicine of the Ear.** Edited by Edmund Prince Fowler Jr., M.D., Sc.D., Assistant Clinical Professor of Otolaryngology, College of Physicians and Surgeons, Columbia University; Assistant Surgeon, Manhattan Eye, Ear and Throat Hospital, New York. With a foreword by John Devereux Kernan, M.D., Professor of Otolaryngology, College of Physicians and Surgeons, Columbia University. Price, \$12.00. Pp. 590, with 350 illustrations and 2 color plates. New York and Edinburgh: Thomas Nelson & Sons, 1939.

This newest addition to the Nelson Loose Leaf Series is a fit companion to "Surgery of the Ear," reviewed about a year ago in this journal. It has about 100 more pages and 50 more illustrations than the latter and is similar in binding and construction, with, of course, the loose leaf feature by which a subscriber, receiving additional material from time to time, keeps his volume up-to-date. All that was said about the Nelson "Surgery of the Ear" is applicable here, and Dr. Fowler deserves congratulations on his able work both as editor and as author of one of the important chapters.

As Dr. Kernan says in his foreword, it is necessary to correlate medicine of the ear with surgery of the ear, as well as with medicine and surgery of the nose and throat and with general medicine, and this has been well done in these two volumes. The present book gives all the essential anatomic, physiologic, etiologic and pathologic data and special tests for aural diseases and indicates when medical or surgical treatment becomes necessary.

The list of eighteen contributors is impressive. They were chosen from the foremost otologists in America, with the addition of two Europeans distinguished for their research work in the field of otology whose names are household words for every student of the ear. The bibliography attached to each chapter is extensive and most useful to the student. Stress is laid on pathologic changes and diagnosis, but treatment is not neglected.

The physiology of the organ of hearing is taken up in great detail and brought up to date, and much space is devoted to the newer diagnostic methods of examination of both the acoustic and the vestibular mechanisms, which of course are based on the physiologic observations and cannot be understood without a thorough knowledge of the latter. Modern methods for the management of the deafened person, including measures for improving his morale, are described, and the methods for prevention of deafness are outlined.

It seems to the reviewer that this work is excellent for the graduate student, the otolaryngologic hospital resident and the otologist but that much of it is too technical to appeal to the general practitioner. At the other extreme, however, there is much information that will appeal to the intelligent social worker and teacher and to other lay persons whose work is among school children and deafened adults.

The illustrations are excellent. If any portion should be singled out for criticism, it would be the inclusion of many pages of case histories. These are doubtless of interest to the student but seem just a little out of place in a work which should be classed as a textbook.

**Les maladies de l'oesophage.** By J. Terracol, Professeur a la Faculte de Medecine de Montpellier, with the collaboration of J. Baumel, S. Belinoff, P. Betoulières, J. Delmas, G. Despons, F. G. Eeman, H. L. Guibert, P. Guns, M. H. Harant, F. Haslinger, P. Lamarque, Mounier-Kuhn, A. Peroni, M. Sargnon, J. Vialle, M. Wisner and M. Worms. Price, 220 francs. Cloth. Pp. 664, with 352 illustrations. Paris: Masson et Cie, 120 Boulevard Saint-Germain, 1938.

This comprehensive volume is an outstanding addition to the literature on the esophagus. It is well edited, and most of the chapters are written with a

minimum of verbosity. It is profusely illustrated with photographs and schematic and colored drawings, which are helpful, particularly to the reader whose knowledge of French is limited. The book is divided into four parts.

Professor Terracol and his collaborators are residents of continental Europe. Four of these men, however, Guns, Eeman, Peroni and Vialle, have been students in the Chevalier Jackson school of Broncho-Esophagology, and Dr. Jackson's teachings are well presented.

The first part of the book takes up anatomic considerations, both macroscopic and microscopic, with a chapter on the physiology of the esophagus. Methods of examination of the esophagus, roentgenography and esophagoscopy, are discussed in detail. The esophagoscopic technic and instrumentarium of Jackson, Moure, Guisez and Haslinger are presented. Haslinger himself is the author of a chapter. Exploration with the catheter and biopsy are briefly discussed. The chapter on accidents following esophagoscopy is well written and should be of great value in preventing such accidents.

The second part takes up pathologic conditions of the esophagus. Malformations, compression and neuromuscular abnormalities all are considered at length, with full notes on methods of treatment. Diverticula are discussed, and the surgical methods of treatment are well presented. Inflammatory lesions, peptic ulcer, tuberculosis, syphilis, diphtheria, esophageal complications of cutaneous infectious diseases, agranulocytosis and parasitic disease are included.

In the third part traumatic conditions of the esophagus are considered; rupture, accidental injury, perforations, abscess, corrosive burns, cicatricial stricture and tracheoesophageal fistulas are presented, with full description of methods of treatment. Continuous string retrograde dilation with flexible bougies for cicatricial stenosis is not mentioned.

The fourth part takes up tumors of the esophagus, benign and malignant. Radiologic procedures, both diagnostic and therapeutic, in the group of cases discussed in this part of the book are given full consideration. The chapter by Eeman on foreign bodies in the esophagus is particularly worthy of mention.

The last chapter is devoted to gastroscopic examination with the flexible tube of Schindler and is an excellent presentation of the subject.

The book is well written and well printed, and its scope and bibliographic reference make it a valuable reference work, despite the fact that it is not provided with an index.

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## News and Comment

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### AMERICAN BOARD OF OTOLARYNGOLOGY EXAMINATION

The American Board of Otolaryngology will hold an examination at the Manhattan Eye, Ear and Throat Hospital, New York, June 3, 4 and 5, 1940.

# Directory of Otolaryngologic Societies \*

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## FOREIGN

### COLLEGIUM OTO-RHINO-LARYNGOLOGICUM AMICITIÆ SACRUM

President: Dr. Louis Ledoux, Brussels, Belgium.

Secretary: Prof. Dr. C. E. Benjamins, Verlengde Heereweg 143, Groningen, Netherlands.

### HUNGARIAN OTOLARYNGOLOGICAL SOCIETY

President: Dr. V. Zimányi, Zárda-u. 48, Budapest II.

Secretary: Dr. G. Kelemen, Reáltanoda-u., Budapest IV.

### SOCIEDAD RIOPLATENSE DE OTO-RHINO-LARINGOLOGÍA (ARGENTINE SECTION)

President: Dr. Raul Becco, B. Mitre 1690, Buenos Aires.

Secretary: Dr. Juan Manuel Tato, Santa Fé 1171, Buenos Aires.

### SOCIÉTÉ FRANÇAISE D'OTO-RHINO-LARYNGOLOGIE

Secretary: Dr. Henri Flurin, 19 Avenue Mac-Mahon, Paris, 17<sup>e</sup>.

## NATIONAL

### AMERICAN MEDICAL ASSOCIATION, SCIENTIFIC ASSEMBLY, SECTION ON LARYNGOLOGY, OTOTOLOGY AND RHINOLOGY

Chairman: Dr. A. W. Proetz, 3720 Washington Blvd., St. Louis.

Secretary: Dr. Leroy A. Schall, 270 Commonwealth Ave., Boston.

Place: New York. Time: June 10-14, 1940.

### AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Frank Brawley, 30 N. Michigan Ave., Chicago.

Executive Secretary: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.

Place: Cleveland. Time: Oct. 6-11, 1940.

### AMERICAN BRONCHO-ESOPHAGOLOGICAL ASSOCIATION

President: Dr. Lyman Richards, 319 Longwood Ave., Boston.

Secretary: Dr. Paul Holinger, 1150 N. State St., Chicago.

Place: New York. Time: June 5, 1940.

### AMERICAN LARYNGOLOGICAL ASSOCIATION

President: Dr. James A. Babbitt, 1912 Spruce St., Philadelphia.

Secretary: Dr. Charles J. Imperatori, 108 E. 38th St., New York.

Place: Westchester Country Club, Rye, N. Y. Time: May 27-29, 1940.

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\* Secretaries of societies are requested to furnish the information necessary to keep this list up to date.

AMERICAN LARYNGOLOGICAL, RHINOLOGICAL AND OTOLOGICAL SOCIETY, INC.

President: Dr. Lee M. Hurd, 39 E. 50th St., New York.

Secretary: Dr. C. Stewart Nash, 708 Medical Arts Bldg., Rochester, N. Y.

Place: Waldorf-Astoria Hotel, New York. Time: June 6-8, 1940.

### SECTIONS:

Eastern.—Chairman: Dr. John R. Simpson, Medical Arts Bldg., Pittsburgh.

Southern.—Chairman: Dr. Walter J. Bristow, Doctors Bldg., Columbia, S. C.

Middle.—Chairman: Dr. Sam E. Roberts, Professional Bldg., Kansas City, Mo.

Western.—Chairman: Dr. Pierre Viole, 1930 Wilshire Blvd., Los Angeles.

### AMERICAN OTOLOGICAL SOCIETY

President: Dr. Horace Newhart, 527 Medical Arts Bldg., Minneapolis.

Secretary: Dr. Thomas J. Harris, 104 E. 40th St., New York.

Place: Westchester Country Club, Rye, N. Y. Time: May 30-31, 1940.

## ROENTGEN DIAGNOSIS OF CANCER OF THE ACCESSORY SINUSES

GEORGE E. PFAHLER, M.D., Sc.D.

AND

JACOB H. VASTINE 2d, M.D.

PHILADELPHIA

The clinical symptoms and examination may be sufficient to permit a diagnosis of cancer of the accessory sinuses, but generally when these symptoms are sufficiently clear the disease is far advanced and hopeless. Early diagnosis and thorough skilful treatment at the beginning are essential for progress. Generally speaking, the diagnosis is made late, and the results obtained by every form of treatment have been discouraging. Generally, it is advisable to combine the information obtained by taking a careful history, performing a careful physical examination and making a careful study with the roentgen rays. It should be the aim of radiologists to obtain the greatest possible amount of detail in roentgenograms taken at various angles that will best show soft tissue effects and yet include bone detail. An ordinary posteroanterior view, including the whole head, and a lateral view made by means of the Potter-Bucky diaphragm are always essential but are only useful for general orientation. Films made to include such large areas do not usually contain enough detail to permit differentiation between benign and malignant disease except in advanced stages.

The interpretation of the evidence of disease in the early stages is difficult. One can suspect cancer from opacity of any localized areas, but one cannot make a diagnosis on this evidence. Other evidences of hyperplastic sinusitis are commonly associated with carcinoma, and a purulent discharge is practically always associated. If one can show destruction of the walls of the sinuses, together with opacity or expansion of the cavity, the diagnosis then becomes less difficult, but that observation means that the condition is advanced. Doubtful lesions should be examined with biopsy.

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Presented before the Third International Cancer Congress under the auspices of the International Union Against Cancer, Atlantic City, N. J., Sept. 11, 1939.

## DIAGNOSIS

The symptoms generally associated with nasal and paranasal neoplasms should be familiar to the roentgenologist. As Dr. Ross Golden has said, "The first step in the diagnosis of a disease is to think of it." Thus, the radiologist should be thoroughly familiar with the history in each case, and in reading films routinely he should think of cancer. One or many of the following signs and symptoms should suggest cancer of the nasal and paranasal cavities.

1. A sense of fulness in the nose—partial or complete nasal obstruction, usually unilateral.
2. Nasal discharge—either mucopurulent or serosanguineous.
3. Pain—headache if the superior anatomic section is involved and neuralgia if the alveolus or the floor of the antrum is involved or if the fifth nerve or its branches are involved. Pains may be referred to the teeth, simulating toothache. Tumors originating in the middle anatomic section frequently produce paresthesia or anesthesia of the cheek.
4. Fetid odors, if necrosis or ulceration is present.
5. Change of the nasal tones of the voice, due to nasal obstruction or blocking of the antrum.
6. Loss or alteration of the sense of smell.
7. In late stages, expansion or destruction of bone, due to pressure atrophy or invasion by the tumor, with swelling of the face, swelling of the alveolus and loss of the teeth.
8. Invasion of the orbit producing such signs as exophthalmos and proptosis.
9. Ulceration of the tumor in the naris, giving rise to hemorrhage.
10. Invasion of the skin with edema and later ulceration.
11. Local extension to the base of the skull, with consequent neurologic symptoms.
12. Metastasis to the regional lymph nodes, causing dysphagia and dyspnea.
13. Distant metastases, producing symptoms which vary with the site. Most of these signs and symptoms are encountered late in the disease.

Unfortunately, that is when most patients present themselves for treatment, there being no characteristic symptoms early in the disease. The clinical diagnosis is often obvious; the roentgenologic diagnosis may be characteristic, based on (1) increased density of the sinuses or nares, (2) expansion or destruction of bone and (3) an irregular outline of the soft tissues shown by opaque mediums.

In the early stages, there are frequently no symptoms. Neoplasm may be discovered as an incidental finding in investigating an inflammatory condition. Such diagnoses may be early enough to warrant some optimism as to the results of treatment.

Routine roentgenograms of the paranasal sinuses may reveal clouding of one of the sinuses, about which additional information is desired. Radiopaque material is then introduced.

Sicard and Forestier<sup>1</sup> first introduced iodized oil as a contrast medium. Reverchon and Worms injected thin oil into the maxillary antrum to permit better visualization on roentgenograms. Fraser<sup>2</sup> confirmed their observations. At present, the rhinologist introduces a dilute radiopaque substance (usually 1 part iodized oil to 1 to 4 parts olive oil) into the sinuses and refers the patient for a prompt roentgenologic study. The method of introduction of the dilute radiopaque oil depends on the cavity to be visualized (fig. 1).

*Radiopaque Oil Technic.*—The antrum is filled, after cocainization and thorough cleansing, by passing the dilute oil through a cannula



Fig. 1.—Roentgenogram of the sinuses of A. J. H., showing carcinoma of the antrum. There was no evidence of destruction of bone. The diagnosis was based on the presence of an irregular, eccentric filling defect, the remainder of the antrum and the other sinuses being clear, and confirmed by biopsy. In this and the subsequent illustrations, *A* indicates the antrum; *E*, the ethmoid sinuses; *F*, the frontal sinus, and *S*, the sphenoid sinus.

through the inferior meatus of the nose into the antrum. Houser<sup>3</sup> advocated irrigation of the sinus preceding injection, followed by suction to empty it, while Proetz<sup>4</sup> recommended that no fluid be introduced

1. Sicard, J. A., and Forestier, J.: Méthode générale d'exploration radiologique par l'huile iodée (lipiodol), Bull. et mém. Soc. méd. d. hôp. de Paris **46**:463 (March) 1922.

2. Fraser, R. H.: Iodized Oil (Lipiodol) in Otolaryngologic Diagnosis, J. Michigan M. Soc. **25**:270 (June) 1926.

3. Houser, K. M.: Diagnosis and Treatment of Primary Malignant Neoplasms of the Maxillary Sinus, Tr. Sect. Laryng., Otol. & Rhin., A. M. A., 1933, pp. 76-84; Arch. Otolaryng. **18**:643-650 (Nov.) 1933.

4. Proetz, A. W.: Displacement Irrigation of Nasal Sinuses, Arch. Otolaryng. **4**:1 (July) 1926.



into the antrum for twenty-four hours prior to the examination. Roentgenograms are then made with four projections: the posteroanterior (stereoscopically), the Water's, the lateral and the verticomenal (or the mentovertical). It is desirable to make at least one of these roentgenograms with the patient in the upright position. Hyperplastic sinusitis produces a uniform concentric narrowing on one or more sides of the cavity. Allergy produces a transitory encroachment on the lumen with

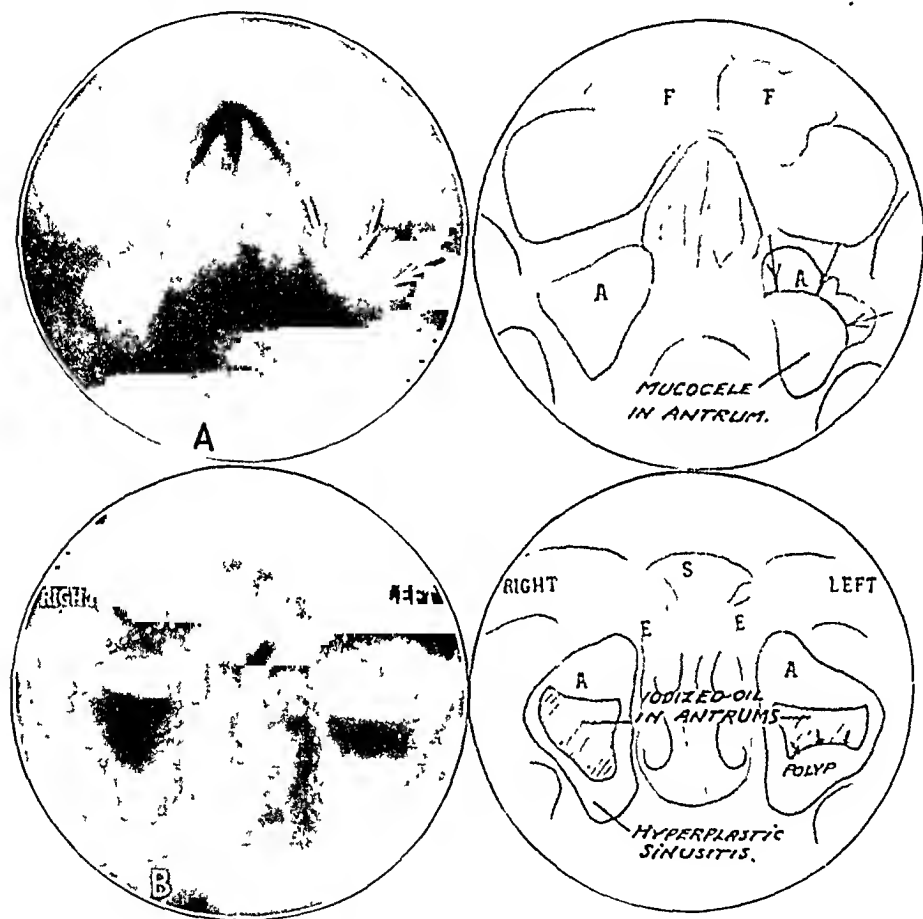


Fig. 2.—*A*, mucocoele in the antrum. Note the smooth, curved, soft tissue shadow arising from the region of the floor of the left antrum. The bony walls are intact. The film was made with the nose-chin, or Waters, projection. *B*, film made with the upright Granger, or 7 degrees, projection. Note the fluid level. Iodized oil has been injected in both antra. Polyps are seen arising from the floor of the left antrum. The thickening of all the mucous membrane of the nasal and paranasal cavities is compatible with hyperplastic sinusitis. The bony outlines are intact.

characteristic lobulated outlines. Mucocoele or adenoma produces large, smoothly outlined filling defects usually arising from the floor of the antrum. Polyps produce a single large, smoothly outlined defect or numerous small ones, projecting into the lumen (fig. 2). Neoplasm

produces an eccentric, irregular filling defect. The remainder of the antrum is clear.

Proetz<sup>4</sup> has devised a displacement method which is valuable in visualizing the ethmoid and sphenoid sinuses. This is of more value in differentiating inflammatory lesions and in determining the rate of emptying of the sinuses. The head is placed with the vertex in a dependent position. The dilute iodized oil is introduced into the nares,

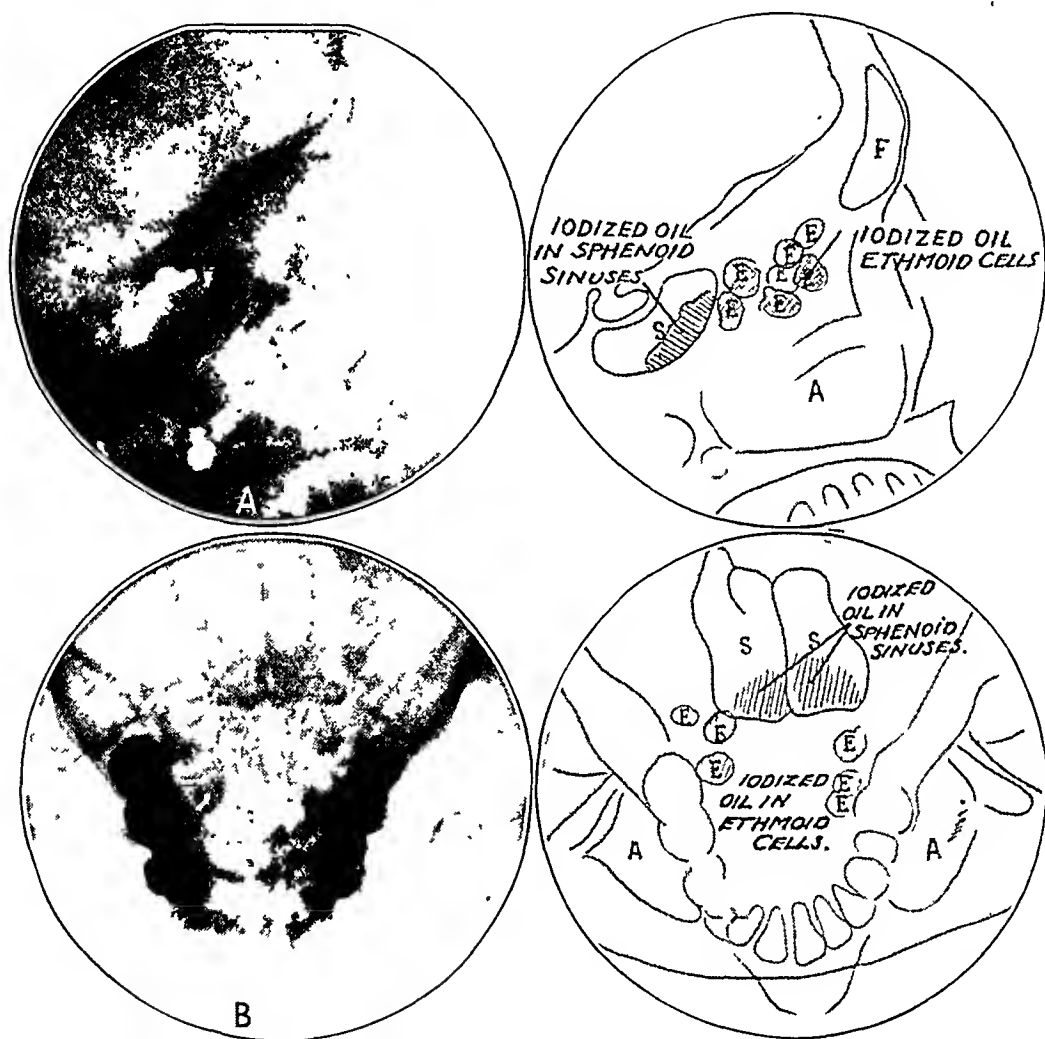


Fig. 3.—*A*, visualization of the ethmoid and sphenoid sinuses after the introduction of iodized oil by the Proetz method. *B*, roentgenogram made in the same case with the verticomental projection.

submerging the ostiums of the sinuses to be examined. Repeated suction with return to atmospheric pressure permits withdrawal of small amounts of air and their replacement with iodized oil. The negative pressure is obtained by the use of a large rubber Proetz bulb, the nozzle of which fits firmly into the nostril. The opposite nostril is held closed, and the patient pronounces the letter "K," which elevates the soft palate and closes the nasopharynx. The ethmoid and the sphenoid sinuses can thus be satisfactorily filled (fig. 3).

Much valuable information can be obtained by the filling of the sinuses, but even more information can be obtained by observing the emptying. The sinuses should be half empty in twenty-four hours and three-fourths empty in forty-eight hours; a trace of the fluid is present seventy-two hours after, and they are empty in ninety-six hours. It can be observed that ample time can elapse, permitting the rhinologist to inject the antrum in his or her office, the patient later reporting to the roentgenologist for examination. The procedure does not require hospitalization or necessitate the rhinologist making the injection in the radiologist's office. One of us (Pfahler<sup>5</sup>) reported a case in which emptying of the antrum was delayed for more than a year, with drainage



Fig. 4.—*A*, posteroanterior film made two weeks after introduction of iodized oil into the antrums. The opaque oil is apparently in the lymphatics, where it was demonstrable four years later. Note that there is still a radiopaque substance in the right antrum. *B*, lateral projection made in the same case.

of the iodized oil through the cervical lymphatics and into the mediastinum (fig. 4).

In introducing the oil through a trocar, care must be exercised not to puncture the lateral wall and introduce the oil into the soft tissue.

*Roentgen Technic.*—Among the most important factors in the diagnosis of malignant disease of the nasal and paranasal cavities is the observance of a careful roentgenologic technic, with an adequate number of good films with various projections. We do not wish to become involved in a discussion of the merits or disadvantages of the Potter-

5. Pfahler, G. E.: Demonstration of Lymphatic Drainage from Maxillary Sinuses, *Am. J. Roentgenol.* **27**:352-356 (March) 1932.

Bucky diaphragm in sinal work. Law stated that excellent "pictures" are produced with the Potter-Bucky diaphragm but that the disadvantages outweigh the advantages. These disadvantages he enumerated as follows: (1) increased distance between the head and the film with consequent increased distortion, (2) a confusing intensification of the structure of cancellous bone and (3) loss of soft tissue detail due to the greater degree of contrast.

Law<sup>6</sup> recommended its use for the verticomental projection. In addition, we think it is necessary for the submentovertical projection of Hirtz and Worms.<sup>7</sup> For the posteroanterior and oblique projections, its use is optional in routine sinal examinations. In the diagnosis of malignant disease of the sinuses, when the appearance of the bony structures surrounding the sinuses is of such diagnostic importance, we recommend the employment of the Potter-Bucky diaphragm.

The following projections are made routinely of the sinuses:

1. Posteroanterior, occipitoglabbellar projection; stereoscopic films with the central ray in the following directions: (*a*) through the base line, (*b*) with 10 degrees cephalic angulation of the tube and (*c*) with 10 degrees pedal angulation of the tube.

2. Lateral projection, usually stereoscopic.

In addition, we frequently make exposures with the following projections:

3. Submentovertical projection of Hirtz or

4. Verticomental projection.

5. Waters,<sup>8</sup> or nose-chin, projection.

When additional information is necessary, films are made as follows:

6. Vertical projection with a sphenoid film in the mouth, as described by one of us (Pfahler<sup>9</sup>).

7. Oblique maxillary projection of Pfahler.

8. Rhese<sup>10</sup> or Goalwin<sup>11</sup> oblique projection.

6. Law, F. M.: Nasal Accessory Sinuses Roentgenologically Considered, in *Annals of Roentgenology*, New York, Paul B. Hoeber, Inc., 1933, vol. 15.

7. Hirtz, E. J., and Worms, G.: Des "périsinusites" profondes, *Ann. d. mal. de l'oreille, du larynx* **45**:833, 1926. Hirtz, E. J.: Les signes radiologiques de l'extension des infections sinusiennes profondes à la base du crâne et au mésencéphale, *J. de radiol. et d'électrol.* **11**:305 (June) 1927.

8. Waters, C. A.: Roentgenology of the Accessory Nasal Sinuses, Describing a Modification of the Occipitofrontal Position, *Am. J. Roentgenol.* **2**:633 (Feb.) 1915.

9. Pfahler, G. E.: (*a*) The Roentgenographic Study of the Accessory Sinuses, with Special Reference to the New Technic for the Examination of the Sphenoid Sinuses, *Ann. Otol., Rhin. & Laryng.* **30**:379 (June) 1921; (*b*) in Discussion on Carr, G. L.: Roentgen Ray Findings in Skull in Cases of Brain Tumors, with Special Reference to Porus Acusticus, *Am. J. Roentgenol.* **4**:405 (Aug.) 1917.

10. Rhese: Die chronischen Entzündungen der Siebbeinzellen und der Keilbeinhöhle, *Arch. f. Laryng. u. Rhin.* **24**:383-449, 1910.

ANATOMIC FACTORS INFLUENCING LOCAL EXTENSION  
AND METASTASES

Hautant,<sup>12</sup> Dechaume<sup>13</sup> and Ruppe<sup>14</sup> divided the nose and paranasal sinuses into three sections:

1. Inferior section—the alveolar process and the floor of the antrum. Tumors within this region metastasize to the submaxillary lymph nodes. They are largely extrasinal in origin and involve the nose and paranasal sinuses secondarily.

2. Middle section—the remainder of the maxilla and the nasal cavity at the same level. Tumors in the second and third sections metastasize to the retropharyngeal nodes. This middle section includes the region where the nares, ethmoid sinuses and antrums are in close proximity, being separated only by thin bony walls. Lesions which occur in this section therefore generally involve all three areas.

3. Superior section—the ethmoid cells, sphenoid sinuses, frontal sinuses and upper nasal cavities. The superior section is separated from the orbits by the thin walls of the ethmoid bones, and involvement of this section is usually associated with invasion of the orbit, with displacement of the eyeball, early in the disease. The cribriform plate offers the only impediment to intracranial extension of the disease from this section.

Öhngren<sup>15</sup> divided the tumors with reference to an imaginary plane extending from the internal canthus downward and posteriorly to the angle of the jaw, the prognosis being influenced by the location of the tumor above or below this plane. The prognosis of tumors situated superior to this plane, he stated, is the more serious. Lesions in the superior and posterior region are in close proximity to the meninges and vessels, with fatal local extension always imminent. Irradiation is usually the only treatment which can be employed above this plane, while irradiation and surgical intervention may be combined for tumors inferior to it. Tumors in the anteroinferior portion of the antrum encroach on the hard palate, loosen the teeth, produce neuralgic pains, invade the nose, expand the cheek and remain relatively accessible to surgical treatment combined with irradiation.

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11. Goalwin, H. A.: The Precise Roentgenography and Measurement of the Optic Canal, *Am. J. Roentgenol.* **13**:480-484 (May) 1925.

12. Hautant, A.; Monod, O., and Klotz, A.: Les épithéliomas ethmoïdo-orbitaires. Leur traitement par l'association chirurgie-radium. Résultats éloignés, *Ann. d'oto-laryng.* April 1933, pp. 383-421.

13. Dechaume, M.: Tumeurs hyperplasiques des maxillaires, *Progrès méd.*, Dec. 8, 1934, pp. 1985-1993.

14. Ruppe, C.: Tumeurs malignes des maxillaires, *Gaz. d. hôp.* **104**:1101 (July 18) 1931.

15. Öhngren, L. G.: Malignant Tumours of the Maxillo-Ethmoidal Region, *Acta oto-laryng.*, 1933, supp. 19, pp. 1-476. Treatment of Malignant Tumors of Upper Maxilla and Ethmoid Bone in Sabbatsberg Ear Clinic, *Nord. med. tidskr.* **7**:135 (Feb. 3) 1934.

## LYMPHATICS OF THE NASAL AND PARANASAL SYSTEM

The lymphatic drainage of the floor of the antrums, alveoli and hard palate is to the submaxillary nodes. The frequency of metastasis to these regional lymph nodes is about the same as with squamous cell lesions in the mouth. In a previous publication by us (Pfahler and Vastine<sup>16</sup>), in a series of 111 cases of intraoral squamous cell carcinoma, there were palpable nodes in 82 cases, in 66 of which, judging by surgical reports, the nodes were neoplastic, approximately 60 per cent of the patients having metastases at the time of presenting themselves for treatment.

The lymph channels of the frontal sinuses, the sphenoid sinuses, the ethmoid cells and the upper portion of the antrums drain into the nose. The first station is to the choanal plexus and thence to the regional



Fig. 5.—*A*, photograph of Miss M. S., aged 15, made on March 1, 1937. Squamous cell carcinoma was present, arising in the nasopharynx and the right posterior naris and involving the right sphenoid and ethmoid regions. Retropharyngeal metastases had occurred. The secondary lymph nodes were involved in the region of the internal jugular vein. *B*, photograph made on April 3, 1937, showing radiodermatitis with disappearance of the nodes. *C*, the patient at present without evidence of malignant disease, two and a half years after coming under our observation.

lymph nodes, i. e., the lateral retropharyngeal lymph nodes. These are difficult to palpate and cannot be seen, and, unless they are large or especial care is exercised in searching for them, metastases from the sinuses will escape attention (figs. 5, 6 and 7). The second lymph stations are the deep cervical nodes, situated low in the cervical region about the jugular vein, the retromandibular and the submaxillary lymph

16. Pfahler, G. E., and Vastine, J. H.: Radiation Therapy in Cancer of the Mouth with Especial Reference to the Use of Pure Gamma Rays, *J. A. M. A.* **96**: 664-669 (Feb. 28) 1931.

nodes. In certain types of carcinoma, the primary lesion and the metastases to regional lymph nodes are not manifest, the first presenting evidence of disease being low in the cervical region in the secondary lymph nodes.

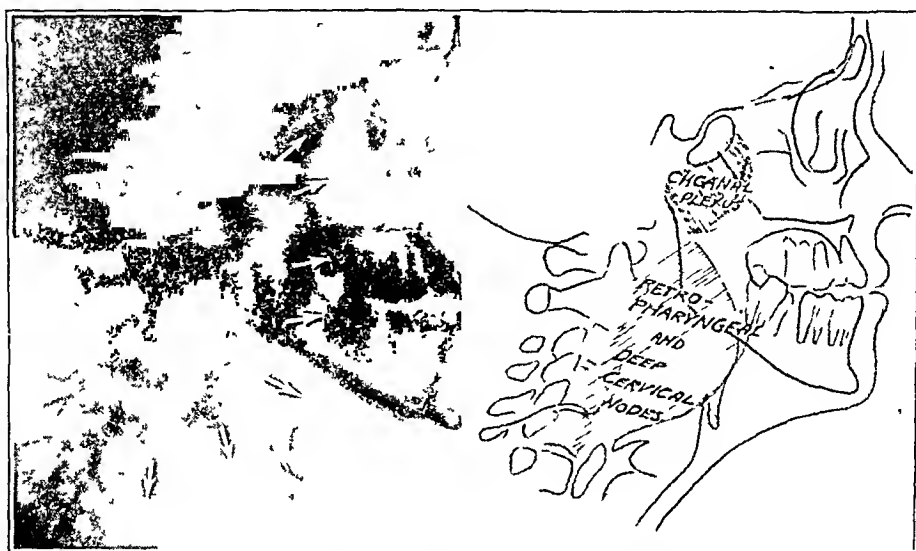


Fig. 6.—Extension to the choanal plexus, retropharyngeal lymph nodes and deep cervical nodes about the internal jugular vein in a patient who recovered under irradiation.



Fig. 7.—*A*, photograph of J. B., carcinoma of the sinuses was present, with metastasis to the secondary lymphatic chain in the deep cervical chain along the jugular vein. *B*, same patient a year and a half later. He is well at present, ten years after irradiation for carcinoma of the sinus with metastasis.

Cancers involving the alveolus, the palate and the floor of the antrum metastasize with much greater frequency than similar lesions above this level. We found metastasis in 60 per cent of 111 intraoral lesions.

Ringertz,<sup>17</sup> in 119 cases of squamous cell carcinoma growing intranasally, found 26.9 per cent of the lesions to have metastasized. Quick<sup>18</sup> found 7.3 per cent to have metastasized in 136 cases of carcinoma of the nasal and paranasal sinuses, and Pichler<sup>19</sup> reported 8.8 per cent metastases in 125 such cases.

Metastases may occur, for instance, to the lungs, liver or suprarenal glands without recognizable evidence of involvement of the regional lymph nodes. Ewing<sup>20</sup> reported 2 such cases. Distant skeletal metastases occur infrequently.

#### CLASSIFICATION ACCORDING TO HISTOGENESIS, WITH THE CLINICAL CONSIDERATIONS AND ROENTGENOLOGIC MANIFESTATIONS OF THE VARIOUS GROUPS

We are radiologists, not pathologists, and, therefore, in the grouping of our cases we have been dependent on the pathologists' reports. These pathologists often employed widely varying classifications. We have tried to use the classification recommended by Ewing,<sup>20</sup> making it conform as closely as we could to the classifications employed by Ringertz<sup>17</sup> and also by Geschickter.<sup>22</sup> A statistical analysis of our own cases based on such varied pathologic reports would be of little value. We have, therefore, chosen characteristic cases to illustrate the different pathologic groups and to emphasize the differential points. For statistics, we are dependent on large series of cases analyzed by pathologists and rhinologists such as the series reported by Ringertz,<sup>17</sup> by Geschickter,<sup>22</sup> by Öhngren<sup>15</sup> and Ahlbom.<sup>23</sup> We have followed and refer the reader to the groups in Ewing's<sup>20</sup> book.

*Papillary Carcinomas.*—This group constitutes a relatively small percentage of the total neoplasms of the nasal and paranasal cavities. These tumors occur in adults. There is usually a history of long duration, with repeated removals of polyps which eventually are found to be carcinomatous. The nasal cavity is the most frequent site. The adjoining

17. Ringertz, N.: Pathology of Malignant Tumors Arising in the Nasal and Paranasal Cavities and Maxilla, *Acta oto-laryng.* 1938, supp. 27, pp. 1-405.

18. Quick, D.: Treatment of Malignant Growths of Nasal Accessory Sinus and Nasopharynx, *Radiology* **14**:191-196 (March) 1930.

19. Pichler, H.: Zur Behandlung bösartiger Oberkiefergeschwülste, *Arch. f. klin. Chir.* **167**:769-775, 1931.

20. Ewing, J.: Neoplastic Diseases, Philadelphia, W. B. Saunders Company, 1931.

21. This footnote has been deleted.

22. Geschickter, C. F.: Tumors of the Nasal and Paranasal Cavities, *Am. J. Cancer*, **24**:637-660 (July) 1935.

23. Ahlbom, H. E.: Mucus- and Salivary Gland Tumours, *Acta radiol.*, 1935, supp. 23, pp. 1-452.



sinuses ultimately become involved by extension. Ringertz<sup>17</sup> reports a case in which a recurrent lesion invaded and destroyed a portion of the palate. Clinically, the symptoms are those of nasal obstruction. There is a mucopurulent discharge.

**Roentgenologic Manifestations:** The nares are both opaque, being filled with the neoplasm. The septum is displaced. The thin medial wall of the antrum is invaded and destroyed. This can probably best be demonstrated by the Waters<sup>8</sup> and the Caldwell<sup>24</sup> projection.

The ethmoid cells, when invaded, are opaque; the cell outlines are lost, and the lateral walls of the ethmoid sinuses may be slightly expanded.

There is interference with drainage due to the nasal obstruction over a long period and consequent clouding of the sinuses not infiltrated by the malignant tumor.

The most important roentgenologic findings with this type of carcinoma are the opacity of the nares and sinuses (which, of course, is not characteristic) and the evidence of destruction of bone, which does not occur with benign papillomas or polyps. A long history of polyps and their repeated removal and recurrence correlated with these two findings should greatly facilitate the establishment of a correct diagnosis.

*Squamous Cell Carcinoma (Transitional Cell Carcinoma).*—This is the most frequently seen type of cancer involving the nares and paranasal sinuses. It constituted 74 per cent of the carcinomas and 62.7 per cent of all the nasal and paranasal malignant growths of Ringertz's<sup>17</sup> series. The incidence is greatest in middle or late adult life. The condition may, however, occur at any age, as evidenced by 1 case in our series, in which it was first observed in a 15 year old girl. Geschickter<sup>22</sup> stated that squamous cell carcinoma rarely occurs in persons under 40 and is most frequent in the fifth, sixth and seventh decades. The duration is usually three to six months before the patient comes under treatment. The antrum is the most frequent site of involvement. In Geschickter's<sup>22</sup> series of 73 cases of squamous cell carcinoma, the antrum was predominantly involved in 50, or approximately 70 per cent. The local growth is large and markedly destructive; it extends widely and readily invades bone. While the antrum is the most frequent site of the primary lesion, extension to adjoining cavities occurs. Of Ringertz's<sup>20</sup> series, the nasal cavity was involved in 49 per cent of the cases; the ethmoid cells, in 43.1 per cent; the alveolar process and the hard palate, in 45.4 per cent; the orbit, in 22 per cent. He found the antrum involved in almost all cases.

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24. Caldwell, E. W.: Skiagraphy of the Accessory Sinuses of the Nose, *Am. Quart. Roentgenol.* 1:27-35 (Jan.) 1907; reprinted, *Am. J. Roentgenol.* 5:569-574 (Dec.) 1918.

There is a wide variation in the cell differentiation in squamous cell tumors and in different parts of the same tumor. The radiosensitivity, therefore, varies, conversely to the degree of differentiation. Polyposis is present in about a third of the cases of squamous cell carcinoma, but the association of polyposis is less frequent with this type of lesion than with papillary or cylindric cell carcinomas. There is a frequent history, however, of sinusitis, either with or without polyps.

**Clinical Considerations:** The symptoms are usually those of pressure or obstruction. The naris is obstructed. The sense of smell may be lost (anosmia). There may be ulceration with hemorrhage (epistaxis) or a bloody mucopurulent discharge. A change in the vocal tones occurs. The lateral walls of the antrum are pushed out, with consequent swelling of the face. Later, there is edema of the tissue of the cheek, with fixation and possible ulceration, due to invasion of the tumor cells. If the orbit is invaded, there is exophthalmos or upward displacement of the eyeball. The lacrimal duct may be obstructed, with resulting lacrimation.

Lesions which extend downward through the palate and alveolus produce neuralgic pains and toothache. Many of the patients first consult a dentist because the pain is referred to the teeth. The teeth become loose due to invasion of the alveolus by the tumor tissue, and bulging of the alveolus or palate may occur. There is tenderness on pressure over the antrum.

Puncture of a roentgenologically opaque antrum returns a bloody fluid and no pus.

Examination of the throat and opposite naris usually gives negative results.

**Roentgenologic Manifestations:** Houser<sup>3</sup> stated that roentgen examination, with or without filling of the sinuses with an opaque oil, frequently does more than any other method to suggest the presence of a growth or at least arouse suspicion of such a lesion.

There is usually homogeneous clouding of the antrum. The posterior and lateral bony walls of the antrum are thick, and, therefore, their destruction is rarely observed roentgenologically. The medial wall is thin and is seen in the posteroanterior films to be destroyed. The naris is filled laterally, and possibly the entire naris is clouded, and the septum is displaced to the opposite side by pressure. The anterior wall of the antrum is thin and frequently bulges. Later the bone is destroyed either by pressure atrophy or invasion of the bone by the tumor or by osteomyelitis resulting from infection which so often accompanies neoplasms in the nasal accessory sinuses.

The anterior wall of the antrum is best demonstrated by the oblique maxillary projection, first described by one of us (Pfahler). Extension downward with destruction of the bone frequently occurs as a result of invasion of bone by the tumor. This invasion should be sought in

cases of neuralgia particularly referred to the teeth. The floor of the antrum also is probably best demonstrated with the oblique maxillary projection or with dental or sphenoid films inside the mouth.

The orbit is invaded through the thin roof of the antrum. The various posteroanterior projections and the oblique projection described by Rhese<sup>10</sup> and later by Goalwin<sup>11</sup> are valuable in demonstrating destruction of the various walls of the orbit.

The posterior wall of the antrum is thick and is rarely destroyed, either by pressure atrophy or by invasion by the tumor, but we have repeatedly observed by the lateral projection either a laminated appearance or a loss of sharpness of this wall.

The maxillary sinus, the ethmoid cells and the naris are all in close proximity, and, therefore, a squamous cell tumor which is primary



Fig. 8.—*A* and *B*, photographs of Mrs. M. H., made on April 11, 1924. Squamous cell carcinoma of the right antrum was present. Note the swelling of the cheek due to expansion and destruction of the lateral wall of the antrum. *C*, photograph made on Feb. 20, 1925, after electrocoagulation and irradiation. *D*, photograph made on Oct. 14, 1927, showing no evidence of disease. The patient died from metastasis thirteen years after first coming under observation.

in one eventually involves all, the exact point of origin being indeterminate. Involvement of the ethmoid cells is manifested by clouding in both the posteroanterior and the oblique projection. The cell outlines, which are normally recognizable in the lateral projection, are lost. By the posteroanterior projection, i. e., the 23 degree projection and the 17 degree, or Granger,<sup>24a</sup> projection, one can see lateral displacement of the wall of the ethmoid bone. The lateral wall of the ethmoid bone, adjoining the orbit, is thin and is, therefore, quickly destroyed by a tumor involving the ethmoid sinuses, with extension into the orbit and resulting exophthalmos (figs. 8, 9 and 10).

24a. Granger, A.: *A Radiologic Study of the Paranasal Sinuses and Mastoids*, Philadelphia, Lea & Febiger, 1932.

Extension of the tumor into the base of the skull has been observed by us and can best be demonstrated by the verticomental projection, the projection of the base on a sphenoid film placed in the mouth, as described by one of us (Pfahler<sup>2b</sup>), or by the submentovertical projection, described by Hirtz.

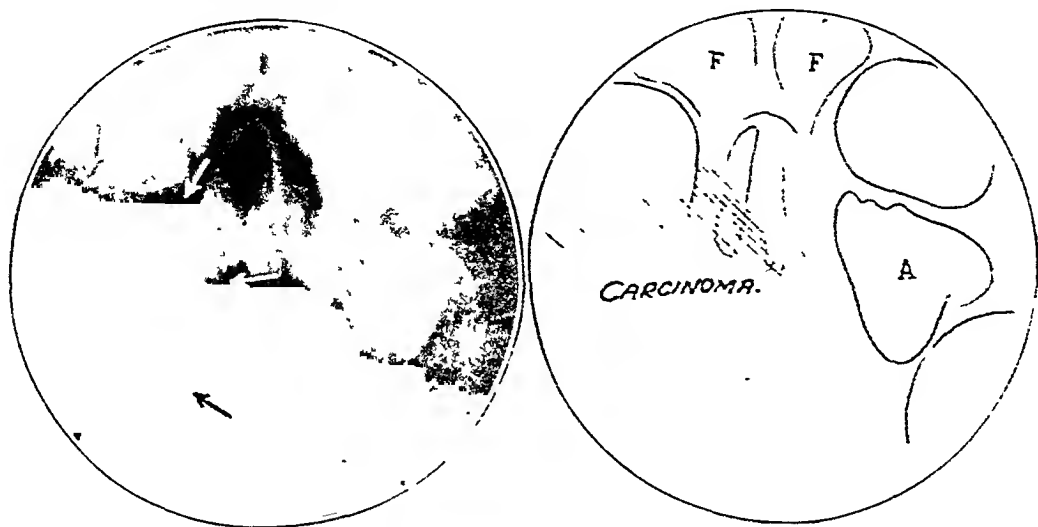


Fig. 9.—Posteroanterior film (Waters projection) of the sinuses of Mrs. M. H., showing squamous cell carcinoma. Note the opacity of the antrum and nares, greater than would occur in inflammation. Note the destruction of the floor of the antrum and the expansion and destruction of its lateral wall.

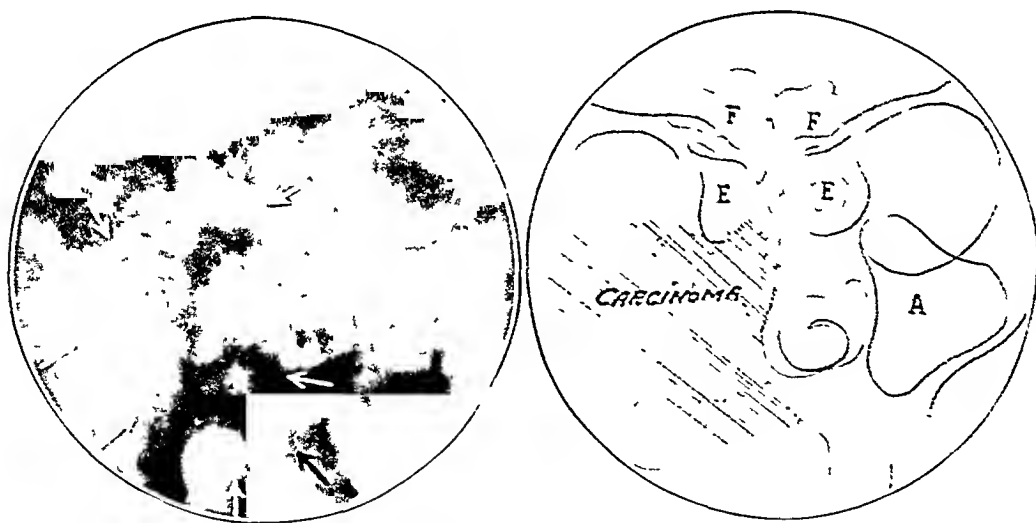


Fig. 10.—Posteroanterior film of the sinuses of Mrs. M. H., showing a squamous cell carcinoma arising in the right antrum. The floor of orbit is destroyed, with invasion and clouding of the orbit. The lateral wall of the maxilla is destroyed. The medial wall of the antrum is lost, and the disease fills the right naris.

The sphenoid and frontal sinuses are rarely involved primarily by squamous cell carcinoma, the lesion usually being primary elsewhere in the nasal or paranasal cavities with extension to these sinuses. In case of involvement of the sphenoid sinuses, they are clouded; their

outlines lose their clearcut margins, and the Granger <sup>24a</sup> line is lost or is hazy. The Granger line is lost also in the presence of inflammation of the sphenoid sinuses and as a result of pressure atrophy from a pituitary tumor, and loss of the Granger line must, therefore, not be considered pathognomonic of malignant disease of the sphenoid sinuses.

**Radiosensitivity:** The tumor is moderately radiosensitive. Ringertz <sup>17</sup> reported a 26.0 per cent three year curability and a 20.5 per cent five year curability for this type of lesion. He found a smaller percentage of recurrences with lesions treated by surgical measures (electrocoagulation) plus irradiation than with those treated by surgical measures alone.

**Carcinoma of the Basal Cell Type (Salivary Gland Type of Carcinoma).**—This type of carcinoma is moderately frequent. It constituted



Fig. 11.—*A*, photograph of Mrs. R. J., aged 37. Carcinoma of the basal cell type (salivary gland type of tumor) was present. Note the swelling of the alveolus. The alveolus, hard palate and antrum were invaded. The condition was treated by irradiation only. *B*, photograph of the same patient, twenty months later, showing symmetric facial bones after irradiation. The patient lived over seven years and then died of recurrence. The roentgenograms made in this case cannot be found.

10.8 per cent of the carcinomas and 9.7 per cent of all the malignant tumors of the nasal and paranasal cavities in Geschickter's <sup>22</sup> series. This corresponds closely to Ringertz's <sup>17</sup> series, in which it constituted 9.1 per cent of the carcinomas and 7.7 per cent of all malignant tumors of the nasal and paranasal cavities (fig. 11).

The incidence is greatest in middle or late adult life. The condition may occur at any age from infancy to old age. The average age in 428 cases of the malignant mixed salivary gland type of tumor collected from the literature by Heincke <sup>25</sup> was 49 years. This corresponds closely

25. Cited by Ringertz.<sup>17</sup>

to Paus's <sup>26</sup> series of 76 cases, in which the average age was 48 years, and Ahlbom's <sup>23</sup> series of 254 cases, in which the average age was 52 years. It should be borne in mind that, although the tumor occurs more frequently in adult life, it may occur in childhood or even in infancy (Palma,<sup>27</sup> Wood <sup>28</sup> and Barmwater <sup>29</sup>).

The lesion is slow growing, firm and rather well encapsulated. The duration of the disease before treatment is usually rather long, ranging from several months to several years.

The tumor practically always occurs below Öhngren's line, i. e., in the inferior or lower middle section described by Hautant, Dechaume and Ruppe. The majority occur in the alveolus or hard palate and involve the anterior nasal cavities by extension. Primary involvement is rare in the ethmoid and sphenoid sinuses and has not been observed in the frontal sinus.

Microscopically, the tumor resembles the malignant tumors arising in the salivary glands and elsewhere.

Clinical Considerations: The tumor is firm and well encapsulated. It rarely ulcerates and, therefore, bleeding rarely occurs. There is usually a history of a nasal discharge. Symptoms due to encroachment on the naris appear, such as obstruction to breathing and change in voice. There is swelling of the hard palate and alveolus, accompanied by some pain. As the antrum is invaded and the wall is expanded, swelling of the face occurs, and occasionally this is accompanied by loosening of the teeth. The patient may have first consulted a dentist because of pain and swelling of the alveolus and had several teeth extracted, with relief. Exophthalmos or other displacement of the eye is observed less frequently with this lesion than with other types of carcinoma, although the orbit may be invaded by an extensive advanced basal cell lesion.

Roentgenologic Manifestations: With an early lesion, destruction of the alveolus or hard palate is first observed. The teeth may be surrounded by soft tissue, the bony socket having been completely destroyed. Later there is a homogeneous opacity of the antrum, with destruction of the floor and expansion of the walls, particularly the anterior wall of the antrum, with loss of the bony outline due to pressure atrophy or invasion of bone, best seen by the oblique maxillary projection. The thin medial wall of the antrum is destroyed; the soft

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26. Paus, N.: Mischgeschwülste des Gesichts, Beitr. z. path. Anat. u. z. allg. Path. **70**:96-120, 1922.

27. Palma, R.: Riproduzione tardiva di un tumore misto della parotide, Ann. ital. di chir. **5**:577, 1926.

28. Wood, F. C.: The Mixed Tumors of the Salivary Gland, Ann. Surg. **39**: 57 and 257, 1904.

29. Barmwater, K.: Einige Fälle von Endotheliom in der oberen Luft- und Speisewegen, Acta oto-laryng. **16**:1-14, 1931.

tissue tumor can be seen at the periphery of the naris or completely filling it. With hyperplastic sinusitis the naris is obstructed by the enlarged turbinates, which can be recognized roentgenologically, while with malignant invasion the obstruction is seen as a homogeneous clouding of the naris which is not influenced by its structures. The septum is displaced toward the opposite side. The opposite naris and the sinuses not infiltrated are usually clear. These observations are best made by the Caldwell,<sup>24</sup> Granger<sup>21</sup> and Waters<sup>8</sup> projections.

The ethmoid sinuses are occasionally primarily involved and are frequently secondarily involved, with a resulting homogeneous clouding of the entire area, seen by the posteroanterior projections, and with lateral bulging or expansion of the lateral wall of the ethmoid cells and invasion of the orbit. Oblique views with the Rhese<sup>10</sup> projection are of value in the interpretation. The bony outlines of the ethmoid cells, normally seen by the lateral projection, are lost. Encroachment on the air space of the nasopharynx can be recognized in the films made with the lateral projection.

Radiosensitivity: Stewart<sup>25</sup> classified the tumor with regard to radiosensitivity with squamous cell carcinoma of the oral region. Geschickter<sup>22</sup> stated that it is as radiosensitive as lymphoepithelioma, which is highly radiosensitive. Ahlbom<sup>23</sup> found that 15 of 21 such tumors observed by him were either markedly or moderately sensitive to irradiation. Ringertz<sup>17</sup> material overlapped that of Ahlbom, and he corroborated the latter's finding. Ringertz<sup>17</sup> reported 10 to 17 patients alive three to fourteen years after treatment.

*Cylindric Cell Carcinoma (Adenocarcinoma).*—Geschickter<sup>22</sup> found this to be a rare form of carcinoma. He included the Schneiderian type of carcinoma in this group, and it then made up only 10.8 per cent of the carcinomas arising in the nasal and paranasal cavities. Cylindric cell carcinomas and adenocarcinomas together constituted the lesion in 12.6 per cent of all Ringertz<sup>17</sup> cases of carcinoma. The percentage of adenocarcinoma in our series of cases was considerably higher than in either of these. Various pathologists examined the tissue in our cases, and percentages are, therefore, of questionable value.

The incidence is greatest above the fourth decade.

The duration of the condition before treatment is several months to several years, although the exact time of malignant changes is uncertain, since there are associated polyps and a history of frequent removal of polyps over a period of years in a high percentage of the cases.

The growth resembles a polyp or adenoma in appearance and is usually nasal in origin, that in 13 of 15 cases of Geschickter<sup>22</sup> arising from the nasal mucosa. Differentiation, clinically, may be suggested by the irregular, ulcerated surface of the polyps which have undergone malignant changes. They are friable and bleed easily when manipulated.

Cylindric cell carcinoma is a rapidly growing tumor which usually extends widely, filling the naris, destroying bone, invading several of the sinuses and expanding the walls; it involves the middle and superior sections described by Hautant and others. The most common site is where the ethmoid region, the antrum of Highmore and the nasal cavity adjoin.

**Clinical Considerations:** Two types of clinical picture are encountered. In one, the tumor apparently arises in otherwise healthy tissue. The duration of symptoms in such cases is short—several months. The adenocarcinomas secrete mucus, and there is a rather profuse mucopurulent discharge, amounting to rhinorrhea. Later, when ulceration occurs, this discharge becomes sanguineous.

Since the tumor arises frequently in the middle and superior anatomic sections, erosion through the thin lateral wall of the ethmoid sinuses or the superior wall of the antrum occurs, with invasion of the orbit and early displacement of the eyeball and bulging of the cheek.

In a second type, there is a long history of frequent removal of polyps, which ultimately undergo malignant changes. They are irregular, recur rapidly and extend, filling the naris, bulging the cheek and causing exophthalmos. They are friable and bleed easily. The palate and alveolus may be invaded late in the disease. Pain is mild or absent. Nasal obstruction is one of the first symptoms with either type. Metastasis occurs less frequently than with the other forms of carcinoma. Death is due to local extension more often than to metastasis.

**Roentgenologic Manifestations:** The roentgenologic picture (figs. 12 and 13) varies with the stage and type of the disease. With tumors occurring in otherwise healthy tissue, the superior nasal meatus is seen to be filled with a homogeneous soft tissue shadow, which early blocks the meatus and causes clouding of the adjoining sinuses, which may be inflammatory or neoplastic.

The ethmoid cells are invaded; bone is destroyed, the cell outlines no longer being recognizable in the films made with the lateral or posteroanterior projections. The thin lateral walls of the ethmoids are at first expanded as evidenced by an increase in the transverse diameter of the ethmoid regions in the posteroanterior films. Destruction of the bone ultimately occurs, and the orbit is invaded. Films in various projections reveal the destruction of bone which is suspected because of the exophthalmos.

The antrum is invaded; the anterior wall is at first expanded and then destroyed by pressure atrophy or infiltration of the tumor. Since the tumor usually arises from the nasal mucosa in the middle and superior anatomic sections, the palate and alveolus are rarely invaded until late in the disease.



The sphenoid sinuses become involved by direct extension. Clouding of the sphenoid occurs, which is sometimes unilateral. The Granger <sup>24a</sup> line is lost. In such cases films should be made with the submento-vertical or the verticomental projection or the vertical projection with a sphenoid film in the mouth, because of the great frequency of extension

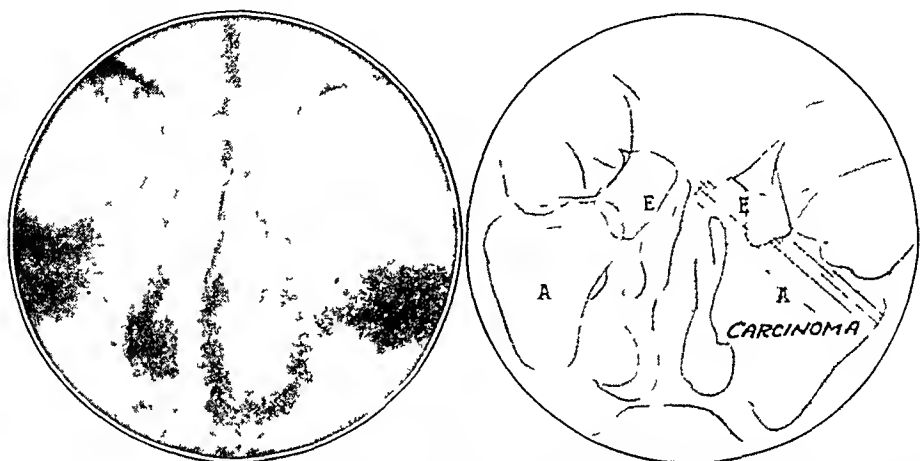


Fig. 12.—Posteroanterior film of the sinuses of Mr. G. M., aged 60. Carcinoma was present, arising in the left naris and involving the ethmoid sinuses and the antrum on the same side.



Fig. 13.—Roentgenogram of the sinuses of Mr. G. M., aged 60, made with the submentovertical projection of Hirtz, showing a cylindric cell carcinoma producing clouding in the region where the ethmoid sinuses, the antrum and the naris are adjacent, the lesion being primary in the naris. The patient is living and apparently free from cancer three years after treatment.

into and destruction of the bones of the base of the skull, with intracranial extension.

**Radiosensitivity:** Cylindric cell carcinoma or adenocarcinoma is only slightly sensitive to irradiation. The site in which it arises and the rapid local extension, producing such widespread involvement

when the patient comes under observation, both preclude successful surgical removal, so that irradiation, if not the treatment of choice, is the only possible treatment. In instituting treatment, one should be prepared to reach or exceed the normal tolerance of the tissues for irradiation and even then to be guarded in one's optimism.

*Round Cell Carcinomas (Undifferentiated Carcinoma, Transitional Cell Carcinoma, Lymphoepithelioma, Lymphodermal Carcinoma, Schmincke<sup>31</sup> Tumor, Medullary Carcinoma).*—These terms (Ewing<sup>30</sup>) may not be synonymous, but the conditions which they designate all possess certain characteristics which permit them to be grouped together for radiologic purposes. They are all rapidly growing, highly malignant, undifferentiated tumors, which are consequently radiosensitive. Lymphoepithelioma represented 26 per cent of the malignant epithelial tumors in Geschickter's<sup>22</sup> series. The age incidence is variable. Cases are reported of patients from 14 to 70 years of age. Geschickter<sup>22</sup> stated that there is a predominance in young adults. Such tumors grow rapidly, and the duration before treatment is short, usually not exceeding two or three months. Most of them arise in the posterior naris or nasopharynx. The adjoining ethmoid and sphenoid sinuses and antrums become involved by direct extension.

**Clinical Considerations:** The primary lesion is often silent. Metastasis occurs so early to the lateral retropharyngeal lymph nodes that the patient is suspected of having an inflammatory disease of the tonsil or tonsils. The tonsils are frequently removed. Later, the secondary lymph nodes in the retromaxillary, submaxillary or deep cervical region become involved, the patient noticing swellings in these regions, the primary lesion possibly still being silent. Dysphagia and dyspnea occur as a result of involvement or marked enlargement of the retropharyngeal lymph nodes.

There is ultimately a mucopurulent or sanguineous discharge from the nose, and one or both sides later become blocked, with resulting changes of voice and loss of sense of smell. Later the eustachian tube becomes obstructed, and pain in the ear develops, with possible otitis media, rupture of the tympanum, otorrhea and deafness. Metastasis practically always occurs.

**Roentgenologic Considerations:** The radiologist is more concerned with the treatment of such a tumor than with its diagnosis.

The tumor usually arises from the nares or the nasopharynx. The sinuses become involved by direct extension. The ethmoid and

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30. Ewing, J.: (a) Some Phases of Intra-Oral Tumors, with Special Reference to Treatment by Radiation, *Radiology* **9**:359-365 (Nov.) 1927; (b) Lymphoepithelioma, *Am. J. Path.* **5**:99-107 (March) 1929.

31. Schmincke; cited by Fitzhugh, W. M., Jr.: Lymphoepithelioma (Schmincke Tumor), *Arch. Otolaryng.* **28**:376-387 (Sept.) 1938.

sphenoid sinuses are most frequently affected, since the tumor originates in the nasopharynx adjoining them.

The posterior ethmoid cells are involved, and, therefore, they appear clouded, with destruction of their outlines. The lateral walls are not expanded or destroyed, and the orbits are usually not invaded.

The sphenoid sinuses are slightly clouded but probably more from retention of secretion than from infiltration, since destruction of bone is rarely observed.

Extension of the tumor occurs along the lateral wall of the naris, and the thin wall between the naris and antrum is destroyed. This can be clearly demonstrated in films made with the Waters projection. The antrum is clouded late in the disease.

While these changes have been occurring in the nasal and paranasal cavities, the metastatic lesions, both in the first station and in the secondary lymph nodes, have been exceeding the primary lesion in rate of growth and dominating the clinical picture.

**Radiosensitivity:** The tumors of this group are probably the most highly malignant and, consequently, the most radiosensitive tumors encountered in the nasal and paranasal sinuses. They are so malignant that metastasis has usually occurred before the patient comes under observation, and the prognosis must consequently be guarded.

*Schneiderian Carcinoma.*—The tumor first described and so named by Ewing<sup>30a</sup> arises from the Schneiderian membrane, the mucous membrane of the nose. It is not uncommon in young persons, although it may occur at any age. The duration before treatment is short. It is a rapidly growing tumor consisting of highly malignant undifferentiated cells. It is highly radiosensitive. It may grow rapidly, invading bone and involving several of the sinuses. Metastasis occurs in a high percentage of cases and may be the first evidence of the disease. Clinically and roentgenologically, this tumor behaves similarly to the tumors included in group 5 of Ewing, discussed in the preceding section.

*Connective Tissue Tumors.*—Two benign fibromatous tumors, which do not belong in this discussion, are briefly described and illustrated that they may not be confused with malignant tumors. Clinically, they often present problems which are as difficult as those presented by the more malignant tumors.

**A. Juvenile Basal Fibroma:** This occurs usually in males between the ages of 10 and 25 years. If the patient has survived, the tumors usually regress spontaneously after the patient is 20 or 25 years old. These fibromas arise from the ventral periosteal layer of the embryonal occipital plate. The growth is rapid and expansive, invading the

ethmoid sinuses and completely filling the nasopharynx. The orbit is invaded, with resulting exophthalmos. Extension to the cranium occurs through the cribriform plate.

The tumor is smooth in outline and is lobulated. It is questionable whether it ever undergoes malignant changes. Many authors think not. Dabney,<sup>25</sup> Ewing,<sup>20</sup> Naab<sup>32</sup> and others believe it does.

**Roentgenologic Manifestation:** The tumor produces dense clouding. A lateral view reveals the filling of the nasopharynx by soft tissue, as evidenced by a smoothly outlined, lobulated area of increased density. The film made with the submentovertical projection reveals marked increase in the density of the base.

The tumor extends and expands bone. There is atrophy of bone due to pressure, but the tumor does not infiltrate the bony structure.

The nares are first affected as evidenced by an increase in density. The ethmoid cells are next invaded. The density is greater than that observed in inflammatory processes. The walls are expanded—the transverse diameter of the ethmoid region is increased, as seen in films in the posteroanterior projection. Calcification is occasionally observed in the tumor, and this is probably a regressive change.

**Radiosensitivity:** Regression can be effected by irradiation, as evidenced in 2 of our cases, 1 of which is illustrated in this article.

**B. Periosteal Fibroma:** This is a fibroma with no predilection for age or sex. It arises from the septum, from the lateral nasal wall or, rarely, from the maxillary sinuses or ethmoid. The growth is slow but progressive, ultimately extending to the adjacent sinuses and the base of the skull. Extensive new formation of bone usually occurs, with spicules of bone embedded in the soft tissue tumor, which is termed an ossifying fibroma and often confused with the osteomas.

**Fibrosarcoma and Spindle Cell Sarcoma.**—These constitute 4.8 per cent of the 846 malignant lesions descriptions of which were collected from the literature by Ringertz,<sup>17</sup> including those in his own cases and in those of Barnes,<sup>33</sup> Davis,<sup>34</sup> Hesse,<sup>35</sup> Geschickter,<sup>22</sup> Harmer<sup>36</sup> and New and Cabot.<sup>37</sup> They constitute 21.6 per cent of the sarcomas.

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32. Naab, J. P.: Die chirurgische Behandlung der Nasenrachenfibrome, Beitr. z. klin. Chir. **22**:761, 1898.

33. Barnes, H. A.: Malignant Tumors of the Nasal Sinuses, Arch. Otolaryng. **6**:123-138 (Aug.) 1927.

34. Davis, E. D. D.: Carcinoma of Maxilla and Ethmoid: Survey of Notes of Fifty Cases, Brit. M. J. **1**:53-55 (Jan. 13) 1934.

35. Hesse: Zur Behandlung maligner Tumoren des Hals-, Nasen-, Ohren Gebiete, Ztschr. f. Hals-, Nasen- u. Ohrenh. **31**:233-247, 1932.

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The incidence is greatest in middle and late adult life—fourth decade. The tumor grows rapidly, and the duration before treatment is short—several months at most. The most frequent sites are the maxillary and ethmoid bones. The frontal and sphenoid sinuses are rarely involved. The lesion sometimes arises from the surface of the maxillary bone or alveolus, invading the sinuses later. Bone is destroyed, usually by pressure atrophy rather than by infiltration of bone. The tumor is firmly attached to the bone. Microscopic diagnosis is difficult because of the variation of the picture in different sections of the same tumor.

**Clinical Considerations:** The signs and symptoms are mechanical, as unilateral obstruction of the nose, blocking of the lacrimal duct and swelling and expansion of the nose, cheek and alveolus. Pain due to pressure is sometimes experienced and is neuralgic. Hemorrhage occurs. Metastases occur frequently to the regional lymph nodes, lungs or skeleton (spine).

**Roentgenologic Manifestations:** Clouding of the naris without regard to the bony structure in the nose occurs. There is homogeneous opacity of the involved sinus. The lesion progresses rapidly, and, therefore, several of the paranasal cavities may be involved when the patient comes under observation. The orbit is infiltrated, the eye displaced and the soft tissues of the cheek involved. The density, roentgenologically, of the soft tissue tumor is moderate, being greater than that of inflammatory tissue and less than that of such growths as fibromas and osteomas. There is a first expansion of the bony walls of the sinuses and later destruction of the bone due to pressure. The bone appears to dissolve, and the line of demarcation is more pronounced than with carcinoma. A similar clearcut line of destruction of bone is observed with ganglioneuroma involving the orbit. The latter tumor does not arise in the orbit, and although exophthalmos is observed, the sinuses appear clear with it or with glioma.

In cases in which the sarcoma arises from the anterior surface of the maxilla or alveolus, the tumor is firmly adherent to the bone; the underlying bone is destroyed by pressure atrophy or infiltration, usually the former, and there is a smooth, clearcut depression of the bone beneath the tumor.

Metastases should be sought by roentgenograms of the chest and of any portions of the skeletal structure, particularly the spine, if symptoms indicate the possibility of them.

**Radiosensitivity:** The radiosensitivity of this tumor is low, but usually no other form of treatment is possible.

*Osteogenic Sarcoma, Chondromyxosarcoma and Osteoblastic Sarcoma.*—These occur relatively infrequently, constituting only 8.5 per

cent of the sarcomas of Ringertz'<sup>17</sup> series. None were listed by Geschickter. They may occur at any age. The patient was 14 in 1 of our cases.

Osteogenous sarcoma is a slowly growing tumor, which becomes bulky and involves the antrum or a sinus, expanding the walls, infiltrating the bone and laying down new bone which soon obliterates anatomic boundaries. Adjoining sinuses become involved, with bulging of the cheek, alveolus and palate and with exophthalmos. The naris is obstructed. Hemorrhage is a late occurrence. Metastasis is rare.

Roentgenologic Changes: The tumor is large and dense and contains considerable calcification. It extends widely, obliterating the cavities, orbit, naris and bony boundaries. When it is viewed tangentially, radiating spicules can be demonstrated. These are particularly well seen in the alveolus or at the anterior surface of the maxilla, as shown by the oblique maxillary projection. The tumor usually arises from some portion of the maxillary bone.

*Osteoma*.—This lesion is benign and does not belong to the present discussion. It may be confused with osteogenous sarcoma, however, and is, therefore, briefly presented to emphasize the differential diagnostic points. Osteoma appears more frequently than osteogenic sarcoma. It may occur at any age, but is more common in young persons. Eckert-Möbius<sup>38</sup> found it more common in the third decade of life.

In contrast with the osteogenic sarcoma, which originates chiefly below Öhngren's plane, osteoma arises above this plane. Eckert-Möbius<sup>38</sup> listed osteoma as occurring in the following sites: the frontal sinus, 113; the ethmoid sinuses, 53; the sphenoid sinuses, 7, and the antrum, 13. The tumor grows slowly. As a rule, it is not associated with and is not related to inflammatory disease of the nares or sinuses. It rarely produces symptoms other than those related to pressure. It may at times be discovered as a coincidence. We have several patients under observation at the present time whom we examine at yearly intervals to exclude rapid progress.

Roentgenologic Manifestations: The outstanding roentgenologic appearance of the tumor is that of marked radiopacity. The tumor extends moderately but often remains confined to the cavity from which it arises. Over a long period, it may expand the cavity. It is found most frequently in the frontal sinus. Law<sup>6</sup> presented a case in which it arose from a pedicle in the frontal sinus. It filled the sinus, being separated at one stage of its development from the bony wall of the sinus by 1 or 2 mm., the thickness of the intervening mucous membrane.

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38. Eckert-Möbius, A.: Gutartige Geschwülste der inneren Nase und ihrer Nebenhöhlen, Handb. d. Hals-, Nasen-, Ohrenh. 5:107, 1929.

This gone, the appearance of a dark halo surrounded the dense tumor. When the wall of the frontal sinuses is eroded, it is usually the posterior wall, and a meningocele may thus be established. The size of osteomas is variable. The outline is usually sharp and clearcut, although it may be somewhat irregular.

*Myxosarcoma*.—Tumors containing mucin are common; many of the different varieties of sarcoma and carcinoma contain mucin between the cells. There are various combinations, such as chondromyxosarcoma and fibromyxosarcoma. True myxosarcoma is probably rare.

It occurs in young people, from infancy to early adult life, although it may occur at any age. Campo<sup>25</sup> reported a congenital myxosarcoma recognizable at birth.

The tumor is slow growing and prone to recur after removal, the history often covering many years, with several surgical removals and several surgical recurrences. It arises in the inferior section, i. e., the maxilla chiefly. The ethmoid cells may become involved. The surface of the maxilla was involved in most of the few cases recorded in the literature. The tumor projects into the cheek or the mouth. The septum is reported as a common point of origin. The ethmoid and sphenoid sinuses are occasionally involved.

Clinically, swelling of the face occurs. There is swelling of the alveolus or palate. Mechanical obstruction of the nose occurs. There may be bulging of the cheek.

Roentgenologic Manifestations: Opacity of the naris or of one of the paranasal cavities can be demonstrated roentgenologically. The tumor is slow growing, and the bone is expanded more than infiltrated. There are alternate areas of sclerosis and atrophy of bone. There may be bony thickening due to periosteal irritation. Tangential films may show periosteal elevation when the anterior surface of the maxilla or alveolus is involved. This is illustrated in the case of a 15 month old child in our series.

Radiosensitivity: The tumor is relatively radioresistant. Regression can be effected or the growth at least retarded, and irradiation should be used in conjunction with surgical intervention, since the lesion practically always recurs after surgical removal alone. Irradiation should be employed cautiously in young children, since retardation of bony growth may occur, which is deforming and may subject the procedure to criticism.

#### SUMMARY AND CONCLUSIONS

1. To think of the possibility of cancer of the accessory sinuses is the first essential in making the diagnosis.
2. Most diagnoses are made late, and therefore in most cases the condition is incurable.

3. In such a serious disease every possible means of diagnosis must be utilized. This includes the careful taking of the history, thorough clinical observations and a thorough roentgen investigation, with an adequate number of projections and detailed study; finally, a biopsy is essential for the early diagnosis.

4. Cancer involving the accessory sinuses varies in its distribution and characteristics according to the types which we have described. The treatment and management will vary also with these types.

5. In some cases, irradiation alone will give best results. In other types, a combination of surgical or electrosurgical measures and irradiation will give best results.

6. Individual consideration is absolutely necessary in each case, in which the type of disease and its location, extent and duration especially must be taken into account.



# NASAL PLETHYSMOMETRY AS A NEW TEST FOR SINUS THROMBOSIS

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The technic<sup>1</sup> here described is based on the fact that compression of the healthy jugular vein while the other jugular vein is obstructed in most cases causes congestion of the wide venous spaces of the nasal turbinates. The swelling of the conchae can be seen in some cases by anterior rhinoscopic examination (fig. 1), but it can be clearly demonstrated in every case by means of a simple apparatus, the nasal plethysmometer (fig. 2).

The nasal plethysmometer<sup>2</sup> consists of two small inflatable rubber balloons, *A* and *B*, each of which is mounted on one leg of a small manometer, *C*. When one of these balloons or both are introduced into the nose, one can blow them up without displacing the menisci, by means of the bridge, *D*, while the clip, *E*, is placed on the rubber connection, *F*. When the bridge is closed with the clip, *E*, on the rubber connection, *H*, every variation in conchal swelling will result in a displacement of the manometer fluid.

The instrument can be used in two ways, i. e.:

1. Plethysmometria nasalis unilateralis (fig. 3 *A*), in which one balloon is introduced into the nose on the side where the jugular vein will be compressed first and then into the other side. The apparatus is fixed to the nose with adhesive plaster. This method provides a *sensitive* test, but has the disadvantage that the pulse and respiration are clearly visible.

2. Plethysmometria nasalis duplex (fig. 3 *B*), in which the balloons are introduced one into each nostril. This is a *differential* method, by which the pulse and respiration are not recorded and only the difference between the swelling in the right and in the left nostril is recorded.

The balloons must not be inflated too much, because this will empty the venous spaces. A pressure of 10 cm. of water is sufficient to bring the balloon into close contact with the concha. The pressure by which the jugular vein is compressed must allow a free passage in the carotid artery; otherwise, anemia of the nose and the contents of the skull will follow, with paradoxical results. I was able to show that an effect can

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From the Ear, Nose and Throat Clinic of the University of Amsterdam, under the direction of Prof. Dr. A. de Kleyn.

1. van Dishoeck, H. A. E.: *Acta oto-laryng.* 26:53, 1938.

2. Obtainable from Lifa, Breestraat 95, Netherlands.

be obtained with a pressure of 10 cm. of water; with 50 cm. of water one usually has the maximum effect. In order to apply a graded pressure, a special metal collar, mounted on a board with inflatable pads on both sides, was used (fig. 4).

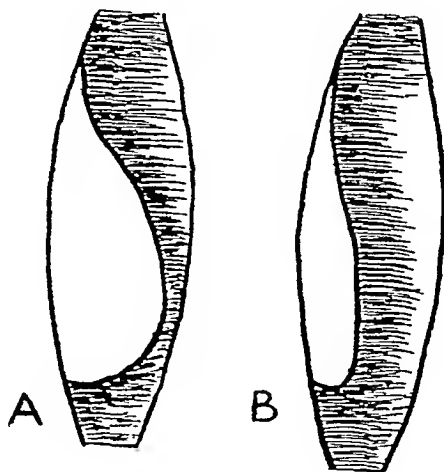


Fig. 1.—Inspection (A) during pressure and (B) after release; conchal swelling in a case of sinus thrombosis during pressure on the jugular vein of the healthy side.

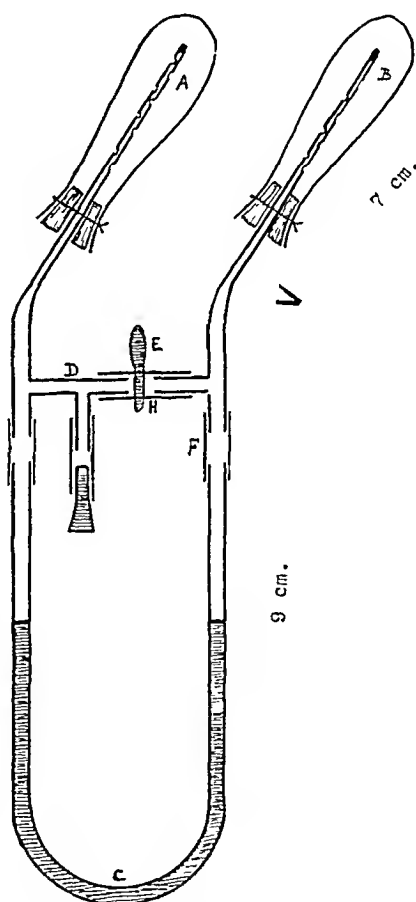


Fig. 2.—Nasal plethysmometer.

In a normal patient, slight pressure on the left jugular vein will cause slight swelling of the left concha and no swelling, or very little, of the right one. Pressure on both jugular veins causes considerable swelling

in both nasal passages. On anterior rhinoscopic inspection, especially, the detumescence when the pressure on the veins is released is clearly seen.

In a case of sinus thrombosis on the left, pressure on the left side of the neck does not produce swelling, while pressure on the right side

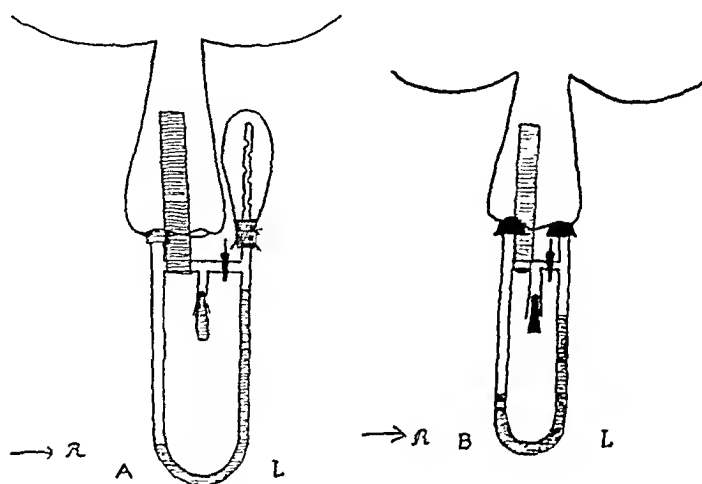


Fig. 3.—*A*, unilateral nasal plethysmometry; sinus thrombosis on the left side; pressure on the right jugular vein. *B*, bilateral nasal plethysmometry; sinus thrombosis on the left side; pressure on the right jugular vein.

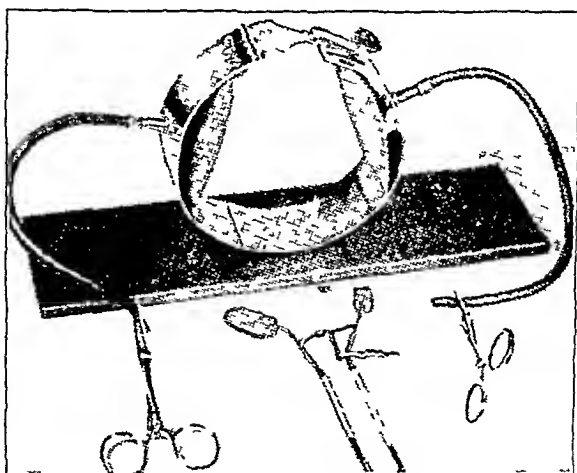


Fig. 4.—Nasal plethysmometer with collar.

causes considerable swelling of the right turbinal and a little swelling of the left turbinal.

The positive symptom is thus the marked difference in the conchal swelling when pressure is applied on the healthy and when it is applied on the obstructed jugular vein.

A preliminary nasal examination is necessary, because the experimental result may be invalidated by the following circumstances:

A. The presence of too little cavernous tissue, on account of nasal crests, operations or atrophy.

B. Previous swelling of the nose to its utmost capacity.

C. Obstruction of the venous connections of the nose and the endocranial system, e. g., in thrombosis of the cavernous plexus.

A definite positive result is diagnostically valuable. Only with congenital aplasia of the sinus is confusion with thrombosis possible.

Conversely, the nasal plethysmometer might be used for detection of the hypoplasia just mentioned. This abnormality is not at all rare. Of 1,022 skulls Luise<sup>3</sup> found a jugular foramen with a diameter less than 1 mm. in 29; the left side was preferred 5:1. Also, according to Rudinger, in 70 per cent of specimens the left sinus is smaller than the right; in these specimens there is usually little development of the left posterior cranial fossa. When ligaturing the sole functioning jugular vein for pyemia or sepsis, while hypoplasia or aplasia of the sigmoid sinus on the other side was present, Ruttin<sup>4</sup> observed edema of the brain.

A slight difference registered by the nasal plethysmometer is not so indicative; in such cases the possibility of mural thrombosis with a partly patent vessel, of total thrombosis with large collateral veins (fig. 8) and of congenital hypoplasia (left sinus) cannot be excluded. The clinical picture of the disease must be taken very much into account.

## RESULTS

Among 16 patients whose sigmoid sinus had been removed from some days to a number of years before examination, the symptom was positive in 13. It is possible that in some of the remaining 3 the sinus had become patent again or that the secondary veins were large enough for the transport of the blood, as has been indicated.

In 7 patients in whom the nasal phenomenon allowed a diagnosis *ante operationem*, this diagnosis could later be confirmed by operation in 6. In 1, however, a marked excursion of the plethysmometer was seen with pressure on the right and on the left as well, but without any difference, while on operation sinus thrombosis was found. It is quite possible that this failure too was caused by the conditions pictured in figure 9. Besides this patient, for 18 other patients with suspected sinus thrombosis the negative result of this test was an additional reason for postponing the operation. Till now these decisions have never been regretted; the findings in later operations or in the further devel-

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3. Luise: Beitr. z. klin. Chir. **38**:642, 1904.

4. Ruttin: Personal communication to the author.

opment of the illness were in the 18 cases not opposed to the interpretation of the nasal phenomenon.

Three cases might be mentioned especially. The first was that of a girl of 17 for whom the decision for a further operation was based solely on the nasal phenomenon, even when previous operations and puncture of the sinus showed no abnormality. This girl had otitis on the right side and a temperature of 40.8 C. (105.4 F.). She presented rigors and a suggestion of nuchal rigidity, and she was *non compos mentis*. During the mastoid operation, the sinus had been well exposed, and one got the impression that the vessel was normal and well filled; on puncture blood was obtained. On the first day after operation the patient was seriously ill. On the second day she again had rigors; on the third day, vomiting and rigors; on this day pyelonephritis was detected; on the fourth day she again had rigors and herpes labialis; on the fifth day the consulting neurologist found general symptoms suggesting involvement of the cerebrum. Lumbar puncture released clear fluid; the blood picture was toxic. Examination with the plethysmometer yielded the following observations: On pressure on the left jugular vein there was a marked excursion, and on pressure on the right vein no excursion at all was noted. A sinistral operation was done and a septic thrombus removed. The girl recovered soon after the operation.

On making a postmortem examination in a second case in which an obstruction was diagnosed by means of the nasal plethysmometer abscess of the temporal lobe of the brain was found and not thrombosis. Also, in another case of abscess of the temporal lobe of the brain the nasal plethysmometer indicated an obstruction. These observations make it probable that this method could be useful also for localization in cases of abscess or tumor of the brain.

A third patient has a fistula of the left ear. In an attempt to demonstrate the symptom of Mygind (i. e., nystagmus on pressure of the vena jugularis), it appeared that on pressure on the left jugular vein nystagmus did not occur but on pressure on the right jugular vein it did. With the nasal plethysmometer, it was found that the left jugular vein was not patent and only the pressure on the right jugular vein registered a result. One might infer that the patient had formerly sinus thrombosis which had not been diagnosed. Probably sinus thrombosis is overlooked in many cases, as this condition does not always produce symptoms (Holderman,<sup>5</sup> Buchband<sup>6</sup>).

#### EXPLANATION OF PHENOMENON

In order to explain the phenomenon, the following diagrams may be of some use. It must, however, be remembered, that they are only hypothetic and that no experimental evidence can be given.

Figure 5 shows a diagram of the normal outflow of the venous blood from the skull. Most of the blood leaves the skull by way of the jugular veins (*A*). A small part of the blood emerges by way of the secondary venous connections, viz., (1) along the emissary veins and the occipital plexus (*B* and *B'*) and (2) along the connections of the cavernous plexus with the pterygomaxillary plexus (*D*), i. e., through the foramen

5. Holderman, J. W.: Lateral Sinus Thrombosis Without Elevation of Temperature, *Arch. Otolaryng.* 1:488 (May) 1925.

6. Buchband, M.: *Monatschr. f. Ohrenh.* 71:977, 1937.

ovale, lacerum and rotundum (C). The possibility, however, is not excluded that occasionally the blood from the pterygomaxillary plexus and thus from the turbinates (E) will partly return to the cavernous plexus.

The external jugular vein (K) is of no importance in establishing the nasal phenomenon. This vessel chiefly drains the blood from the external nose. It has also, however, an anastomosis with the deep nasal veins. The amount of blood flowing along this vessel appears to be negligible. In cases in which the internal jugular vein is obliterated and

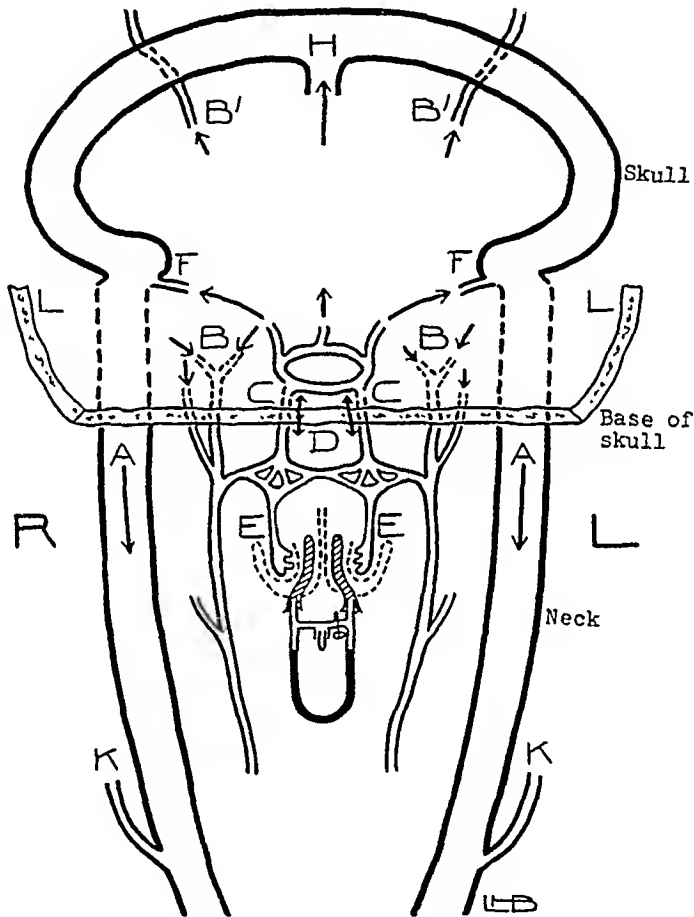


Fig. 5.—Diagram of the normal outflow of the venous blood from the skull.

only the external jugular vein is patent, pressure on this vessel seldom gives rise to a noticeable swelling of the nose. In the study of the problem of venous congestion in jugular compression, the possibility of a rise of the venous pressure in the retinal vessels and a rise of intra-ocular pressure also has been investigated. Even with compression of both jugular veins, no increase of pressure could be demonstrated by using the dynamometer of Sobrantsky and the tonometer of Schiötz. Spontaneous pulsations of the retinal veins occurred in some cases but not at all constantly.

Figure 6 is a survey of the changes which occur in the case of pressure on the left jugular vein. In this case the blood will find its way

chiefly by the contralateral sinus and jugular vein, while the secondary venous connections, *B* and *C*, too, will receive more blood. The result will be congestion mainly in the left part of the skull. In this way the *left* cavernous sinus and *left* pterygomaxillary plexus will be congested, and the result is a stasis of the blood in the wide venous spaces of the conchae. So the left side of the nasal plethysmometer will be depressed a little.

Figure 7 pictures the changes which occur with sinus thrombosis on the right side if the left jugular vein is compressed. In this case, the

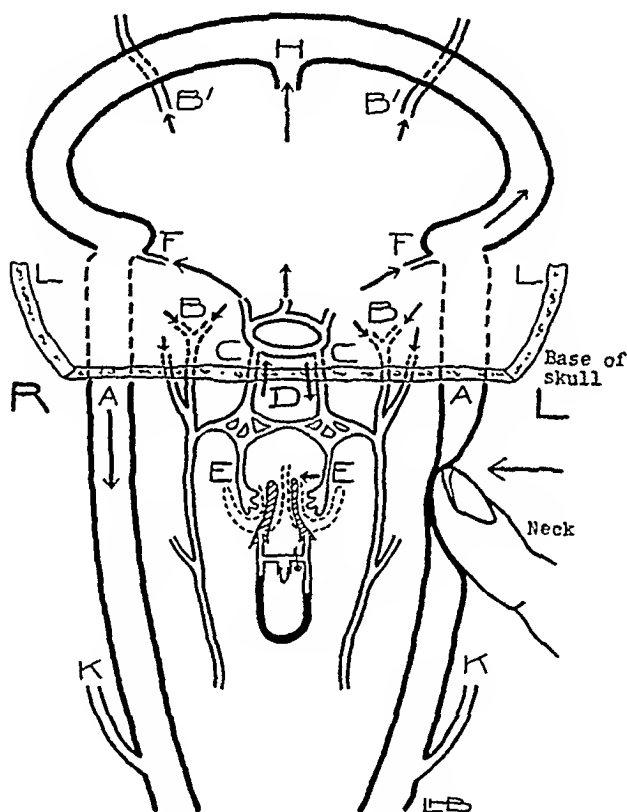


Fig. 6.—Diagram of the outflow of the blood from the skull with pressure on the left internal jugular vein.

secondary venous connections (*B* and *C*) receive all the blood, and a considerable swelling of the turbinates results. One can expect that this swelling will be much more pronounced on the left side, because on the obstructed side compensatory dilatation will have developed.

Figure 8 illustrates an exceptional case. As in figure 3 *A*, sinus thrombosis is present on the right. But in this case, the secondary connections (*B*) are so large that congestion in the cavernous sinus and pterygomaxillary plexus does not result from the pressure on the left jugular vein. Hence, no difference in the excursion of the nasal plethysmometer is produced by pressure on the right and on the left

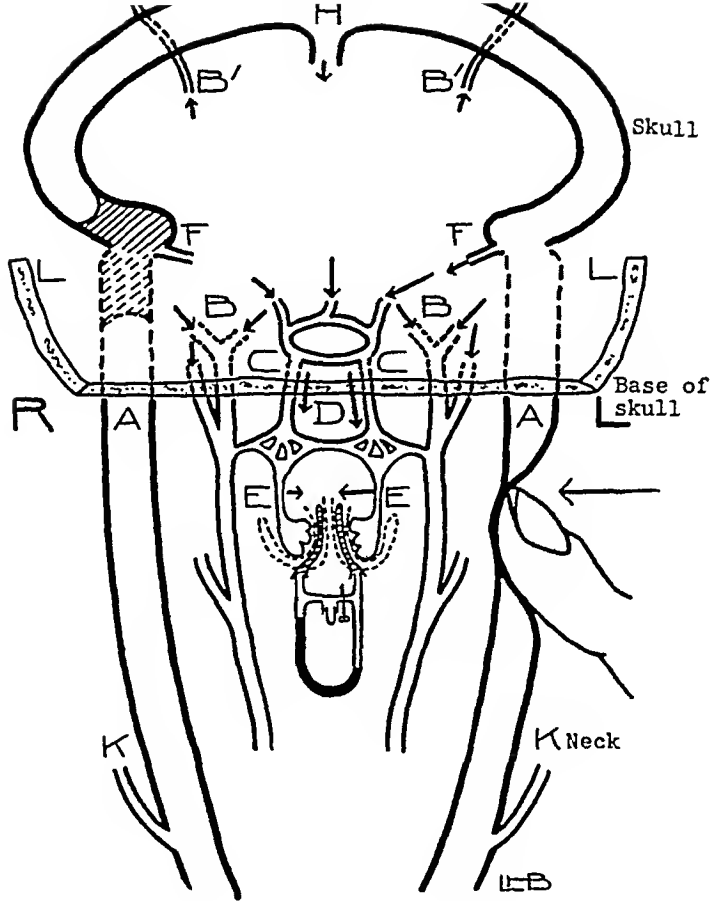


Fig. 7.—Diagram of the outflow of the blood from the skull with sinus thrombosis on the right side and pressure on the left internal jugular vein.

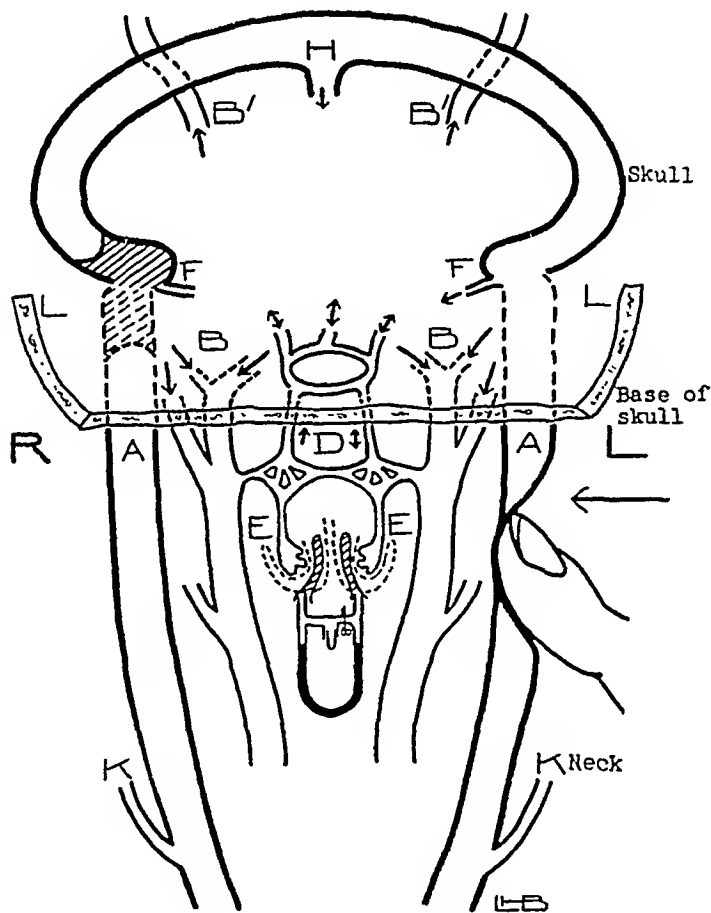


Fig. 8.—Same condition as in figure 7, but with large secondary venous connections of the skull and the neck.



side, and the symptom is negative although sinus thrombosis is present. Moreover, in such cases it is possible that pressure on the right side of the neck will compress the large deep veins. In consequence congestion in the right part of the skull may result, with swelling of the nose on the side where the thrombosis exists.

#### COMPARISON WITH THE QUECKENSTEDT TEST

Probably the explanation and the occurrence of this nasal phenomenon and of the Queckenstedt (Tobey-Ayer) sign may not be the same. This phenomenon is caused by the blood which is leaving the skull by the abnormal route from the cavernous sinus to the pterygomaxillary plexus, while the Queckenstedt sign is caused by the blood which cannot leave the skull in sufficient amount and thus results in increased pressure of the cerebrospinal fluid by displacement or by interference with its absorption. The results of the two tests need not be identical and may complete each other sometimes. It may be expected, for instance, that the nasal phenomenon will be positive in cases in which the Queckenstedt sign fails because of an excessive outflow of blood from the skull by means of the smaller anastomoses (*B* and *C*). The reverse will occur when in a thrombosed cavernous sinus the connection between the cranial cavity and the nose is severed. In this event, as was inferred from a patient with this disease, the nasal phenomenon is not demonstrable. In such cases there is a greater possibility of the Queckenstedt sign being strongly positive.

As an investigation comparing the results of the two tests made on a series of patients in which a lumbar puncture is indicated has not up to now been carried out, only a comparison of statistics is possible. The recent statistics drawn from Björk's extensive investigation of the Queckenstedt test in diagnosing one-sided obstruction are not encouraging. In 16 cases of operatively confirmed sinus thrombosis the test was definitely positive only three times.

The diagnostic value of nasal plethysmometry will be realized only if the test is applied on a considerable scale. Although the number of cases is not large, the results are encouraging enough to justify continuing in this direction.

#### SUMMARY

A new test for sinus thrombosis is described, based on the fact that compression of the healthy jugular vein, the other jugular vein being obstructed, in most cases causes congestion of the wide venous spaces of the nasal turbinates. This swelling can sometimes be detected by anterior rhinoscopic examination, but with a specially constructed *nasal plethysmometer* it can be demonstrated in every case. Some abnormal conditions in the nose and in the venous connections between the skull and the neck which may complicate the interpretation of the test are discussed.

# INFECTIONS OF THE PARAPHARYNGEAL SPACE

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The pharynx is a muscular tube lined by a mucous membrane and ensheathed by the buccopharyngeal fascia. The muscular wall is derived from the superior constrictor muscle and the palatopharyngeus muscle. As Testut and Latarjet<sup>1</sup> pointed out, the superior constrictor muscle is but little developed at the level of the tonsils, which fact is important in order to understand the frequency of penetrating infections originating in the tonsils.

## ANATOMY

At the level of the oropharynx and the nasopharynx a small space, called the parapharyngeal space or the pharyngomaxillary space, borders on the pharynx. In order to study the anatomy of this space three horizontal sections through the skull are used, as pointed out in figure 1. The first section (fig. 2) passes through the middle of the tonsils and shows the following anatomic margins of the parapharyngeal space: mesially, the wall of the pharynx; anteriorly, the internal pterygoid muscle; laterally, the parotid gland, and posteriorly, the prevertebral fascia. Posteriorly and mesially the space continues into the prevertebral space; laterally the space has a free communication with the capsule of the parotid gland, which often has dehiscences.

This space is divided into an anterior and a posterior compartment. At the level of the section shown in figure 3 this division is evidenced by a fascia having its insertion at the styloid process and extending toward the lateral wall of the pharynx. Although this fascia is not always present, the division of the parapharyngeal space is absolutely necessary from a clinical point of view, since the contents of the two compartments are completely different. Within the anterior compartment are found loose connective tissue, fat, the muscles having their insertion at the styloid process, sometimes some lymphatic glands (Hall<sup>2</sup>) and, finally, the lymphatic channels coming from the lateral wall of the pharynx and the tonsils and draining into the lymphatic

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1. Testut, L., and Latarjet, A.: *Traité d'anatomie humaine*, Paris, Gaston Doin, 1931, vol. 4.

2. Hall, C.: *The Parapharyngeal Space: An Anatomical and Clinical Study*, *Ann. Otol., Rhin. & Laryng.* 43:793, 1934.

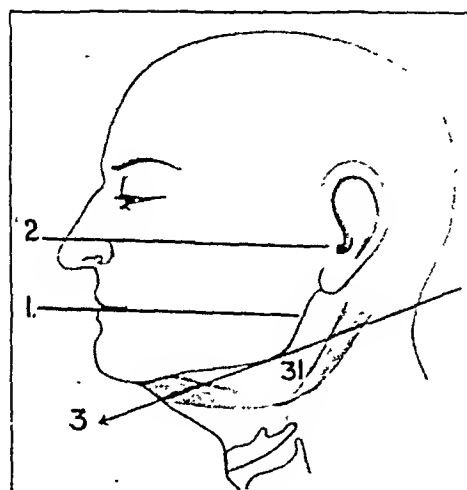


Fig. 1.—The line 1 indicates the level of the section shown in figure 2; the line 2 indicates the level of the section shown in figure 4, and the line 3 indicates the level of the section shown in figure 3. The situation of the stylomandibular ligament is indicated by 31, which corresponds to the ligament shown in figure 3 and marked by 19.

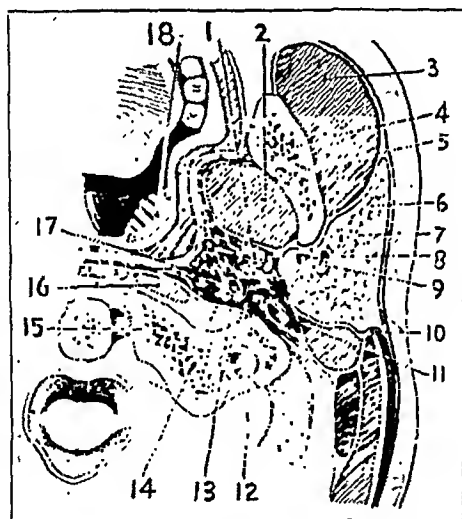


Fig. 2.—Section through the parapharyngeal space in the level indicated by 1 in figure 1. The line 1 indicates the styloid process with the stylohyoid, styloglossus and stylopharyngeus muscles; 2, the internal pterygoid muscle; 3, the masseter muscle; 4, the mandibula; 5, the inferior alveolar artery and nerve; 6, the facial nerve; 7, the parotid gland; 8, the external carotid artery; 9, the vena fascialis posterior; 10, the parotid fascia; 11, the vena jugularis interna and the ninth nerve; 12, the eleventh nerve; 13, the internal carotid artery and the tenth nerve; 14, the superior cervical ganglion of the truncus sympathicus; 15, the atlas with the prevertebral fascia; 16, the longus capitis and longus colli muscles; 17, the hypoglossal nerve, and 18, the tonsillar palatina (Corning, H. K.: *Lehrbuch der topographischen Anatomie*, ed. 3, Wiesbaden, J. F. Bergmann, 1911).

glands within the parotid and the upper portion of the deep cervical glands, situated along the internal jugular vein and the inferior border of the digastric muscle. In the posterior compartment are found the internal carotid artery, the internal jugular vein and the glossopharyngeal, pneumogastric, spinal accessory, hypoglossal and sympathetic nerves.

The second section (fig. 3) passes through the inferior border of the parotid gland at the level of the mandibular angle and shows an actual division of the parapharyngeal space produced by the traversing stylopharyngeal muscle. The posterior compartment is not much changed. It contains the internal carotid artery, the internal jugular vein, the ascending pharyngeal artery, the pneumogastric, glossopharyngeal and hypoglossal nerves and, embedded in the prevertebral fascia, the sympathetic nerve.

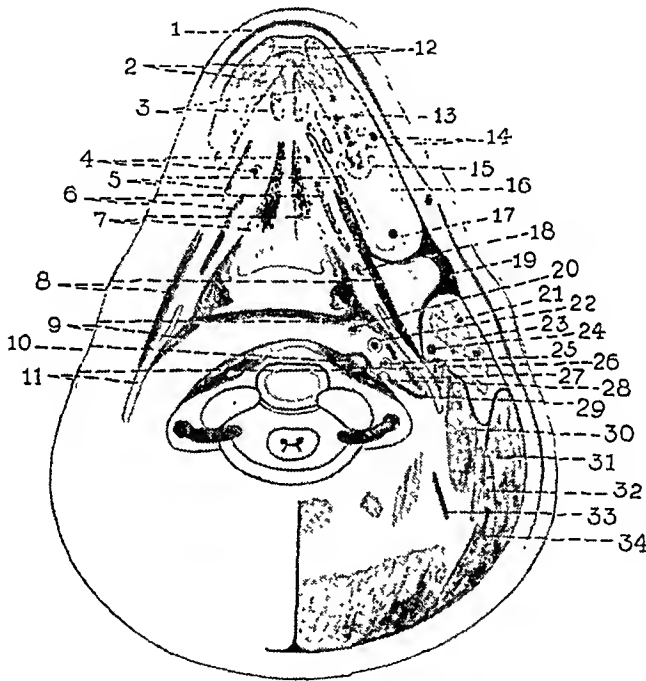


Fig. 3.—Section through the parapharyngeal space in the level indicated by 3 in figure 1. The line 1 indicates the platysma myoides muscle; 2, the mylohyoid muscle; 3, the geniohyoid muscle; 4, the lingual artery; 5, the hyoglossus muscle; 6, the glossopharyngeal nerve; 7, the genioglossus muscle; 8, the styloglossus muscle; 9, the stylopharyngeus muscle; 10, the sympathetic nerve; 11, the styloid process; 12, the digastric muscle; 13, the sublingual gland with the submaxillary duct; 14, the submental artery and vein and the mylohyoid nerve; 15, the lingual nerve; 16, the submaxillary gland; 17, the external maxillary artery; 18, the tonsillar artery; 19, the ligamentum stylomandibulare; 20, the ascending pharyngeal artery; 21, the parotid gland; 22, the internal carotid artery; 23, the parotid gland; 24, the external parotid artery; 25, the vertebral artery; 26, the stylohyoid muscle; 27, the vena vulgaris interna; 28, the hypoglossal nerve; 29, the accessorius nerve; 30, the digastric (posterior belly) muscle; 31, the sternocleidomastoid muscle; 32, the longissimus capitis muscle; 33, the occipital artery, and 34, the splenius muscle. (After Wirtinger.)

Quite different conditions are found as far as the anterior compartment is concerned. Since the lateral margins of the space, seen in the aforementioned section (fig. 2), viz., the parotid gland and the internal pterygoid muscle, are missing at the level of the section shown in figure 3, the anterior compartment passes along the styloglossal muscle and the glossopharyngeal nerve into the narrow space between the genio-glossal and the hyoglossal muscles. This space belongs to the floor of the mouth. Laterally and inferiorly, as cannot be shown in a horizontal section, the anterior compartment is limited by a thickened portion of the superficial cervical fascia, called the stylomandibular ligament. It should be kept in mind that this ligament closes the anterior compartment inferiorly; in other words, the anterior compartment is a cul-de-sac which ends inferiorly at the ligamentum stylomandibulare. This ligament lies between the inferior pole of the parotid gland and the submaxillary gland and is of importance in entering the parapharyngeal space.

The third section (fig. 4) lies above that seen in figure 2 and passes through the maxillary sinus. The posterior compartment is unchanged. It contains the internal carotid artery and the internal jugular vein. Both vessels enter the temporal bone. Between the vessels are the pneumogastric and the glossopharyngeal nerves. Finally, at this level the styloid process with its muscles is found in the posterior compartment.

Of great importance is the anterior compartment. Its margins are as follows: laterally, the ascending ramus of the mandible and the parotid gland; anteriorly and laterally, the external pterygoid muscle; anteriorly and mesially, the internal pterygoid muscle; posteriorly, the posterior compartment and the prevertebral space, and mesially, the lateral wall of the pharynx, which includes at that level the pterygoid process with its venous plexus, the levator veli palatini muscle, the tensor veli muscle and the cartilaginous eustachian tube. Anteriorly the anterior compartment passes into the spaces situated behind the maxillary sinus, viz., the pterygopalatine fossa mesially and the retro-maxillary space laterally.

Also, at this level the anterior compartment largely contains, loose connective tissue, lymph channels and lymph glands. In addition to this, one finds the third branch of the trigeminal nerve (the mandibular nerve) coming from the foramen ovale and dividing into the lingual, inferior alveolar and auriculotemporal nerves, also the internal maxillary artery with its branches, particularly the middle meningeal artery, running up toward the spinous foramen, and finally the veins belonging to the pterygoid plexus.

Summarizing, one gets the following conception of the parapharyngeal space: The anterior compartment lies mesial to the mandible, in its inferior portion mesial to, and in its upper portion behind, the internal

pterygoid muscle. It extends up to the base of the skull and communicates with the dura and its sinuses along the pterygoid plexus, the third branch of the trigeminal nerve and the middle meningeal artery. Inferiorly it ends as a cul-de-sac at the stylomandibular ligament and at the upper pole of the submaxillary gland turning into the floor of the mouth at the posterior margin of the mylohyoid muscle. The anterior compartment contains in its middle portion loose connective tissue, lymph channels, lymph glands, the muscles having their insertion at the styloid process, the internal pterygoid muscle and the parotid gland; in its inferior portion, loose connective tissue, lymph channels, lymph glands and the glossopharyngeal nerve, and in its upper portion, loose connective tissue, lymph channels, lymph glands, both pterygoid muscles,

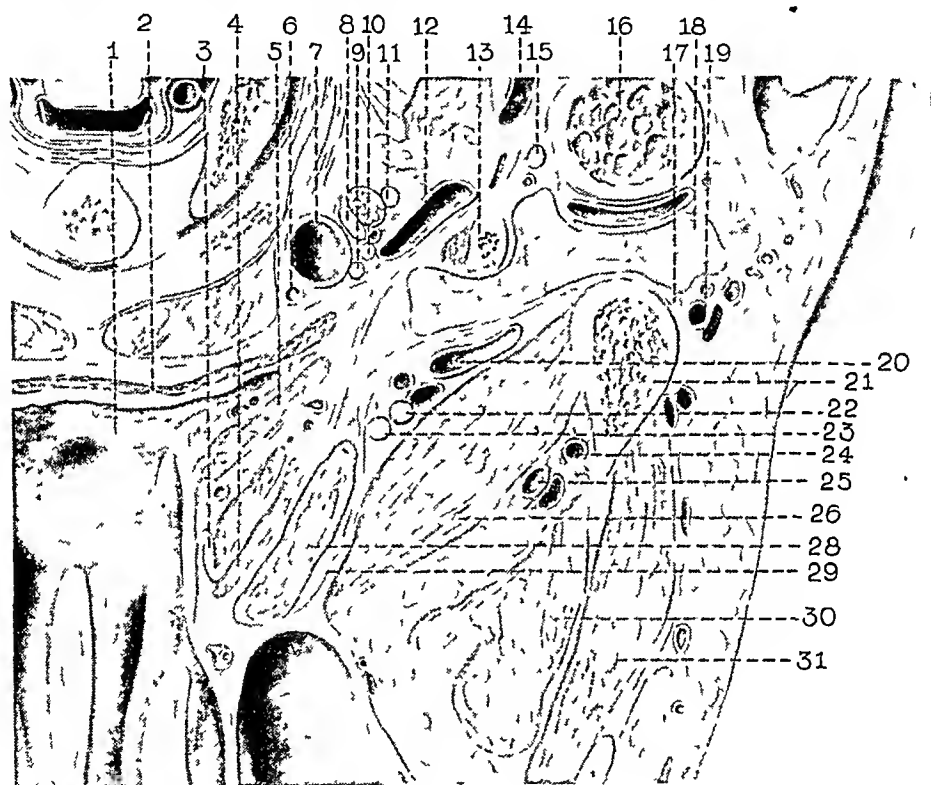


Fig. 4.—Section through the parapharyngeal space in the level indicated by 2 in figure 1. The line 1 indicates the roof of the epipharynx; 2, the superior constrictor muscle; 3, the pterygoid process; 4, the tensor veli palatini muscle; 5, the levator veli palatini muscle; 6, the ascending pharyngeal artery; 7, the internal carotid artery; 8, the vagus nerve; 9, the glossopharyngeal nerve; 10, the accessory nerve; 11, the hypoglossal nerve adjacent to the ganglion superius of the sympathetic nerve; 12, the jugularis interna; 13, the styloid process and the stylopharyngeus muscle; 14, the occipital artery; 15, the facial nerve with its artery; 16, the processus mastoideus; 17, the auriculotemporal nerve; 18, the parotid gland; 19, the superficial temporal artery; 20, the internal maxillary artery; 21, the mandibula; 22, the inferior alveolar nerve; 23, the lingual nerve; 24, the middle meningeal artery; 25, the internal maxillary artery; 26, the external pterygoid muscle; 28, the internal pterygoid muscle; 29, the pterygoid process; 30, the fat of Bichat, and 31, the masseter muscle. (Modified after Testut.)

the muscles of the soft palate, the veins of the pterygoid plexus, the internal maxillary artery with its branches (middle meningeal artery), the third branch of the trigeminus and the parotid gland. The posterior compartment also extends to the base of the cranium and communicates with the dura and its sinuses along the internal carotid artery, the internal jugular vein and the posterior cranial nerves. Inferiorly it extends to the upper aperture of the chest. The chief contents of this compartment are in all levels essentially the same: loose connective tissue, the internal carotid artery, the internal jugular vein, the deep cervical glands, the cranial nerves and the sympathetic nerve.

#### PATHOLOGY

The parapharyngeal space often becomes infected. The source of infection is usually inflammatory disease of the mucous membrane of the pharynx, particularly of the tonsils. My associates and I have observed at the Polyclinic in Vienna 20 cases of infection of the parapharyngeal space.<sup>3</sup> In 16 instances the infection followed inflammatory disease of the mucous membrane of the pharynx; in 1 it followed a tonsillectomy; in a second, inflammatory disease at the base of the tongue; in a third, carcinoma of the tonsil, and in another a radical operation on the middle ear. The last case is of particular interest.

CASE 1.—A man, 33 years old, had had a radical operation on the left side in 1929 because of cholesteatoma of the middle ear. After the operation perichondritis developed. On May 6, 1936, he complained of pain in his left ear. On May 8 his temperature rose to 100.4 F. He complained of pain on opening his mouth and of diplopia. The trismus increased. On May 12 he again had a temperature of 100.4 F. The clinical findings were deformity of the concha after perichondritis, membranous atresia of the external auditory canal, a little fetid secretion from the external canal, a little swelling in the region of the parotid gland, trismus and paresis of the left abducens nerve. On May 14 the ear was reopened. A mass of tough connective tissue was found within the cavity of the mastoid, the middle ear and the external canal. After the removal of this mass pus drained from the middle ear. A new plastic operation could not be performed, since the posterior wall of the membranous canal was absent. On May 15 and 16 the temperature was 103.3 F.; on May 17, 101.5 F. When the swelling in the region of the left parotid gland was compressed, a considerable quantity of pus escaped through the anterior wall of the external canal. With a probe, a fistula was found extending from the anterior wall of the external canal into the parapharyngeal space. On May 19 the fever decreased, but the anterior pillar of the left tonsil was definitely red. On May 22 the temperature was normal, but the patient still had diplopia, and through the fistula in the external canal pus still drained. On May 30 the diplopia disappeared and mastication was normal. On June 4 a granulomatous mass was found at the junction of the cartilaginous and the bony external canal in the anterior wall. The fistula was still draining. On August

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3. Some of these cases have been published extensively by my former assistants. Dr. Waldapfel and Dr. Grabscheid, and me.

5 the temperature was again 102.2 F.; the region of the left parotid gland again was swollen. In the afternoon of the same day the pus spontaneously broke through the fistula into the external canal, and a decrease of temperature and pain followed. By August 11 the patient had recovered.

In this case the pus broke through a fistula in the anterior wall of the external canal into the parapharyngeal space. In addition to this the infection also broke into the meninges and produced paresis of the abducens nerve, probably by serous meningitis. All these unusual complications developed because of the firm connective tissue which closed the external canal.

Aside from such rare sources of infection of the parapharyngeal space interest is focused just on the infections which originate in the mucous membrane of the pharynx, particularly in the tonsils. It is well known that these infections can travel by three different routes: (1) They can pass by contiguity from the mucous membrane into the parapharyngeal space; (2) they can pass along the lymph channels, and (3) they can pass along the blood vessels.

A few years ago these different pathways were intensively discussed. Today it is known that the infection passes most often along the pathways mentioned under 1 and 2. However, the question concerning the pathways has but theoretic interest, since, as a rule, infections do not pass into the parapharyngeal space along a single way and since even microscopic examination does not always permit one to decide whether thrombophlebitis of the veins has to be considered as a cause or as a result of the suppuration within the surrounding connective tissue. Sjöberg<sup>4</sup> published 2 cases in which the condition was microscopically proved. Both the patients had thrombophlebitis of the veins and suppuration within the connective tissue of the parapharyngeal space. Sjöberg explained the thrombophlebitis of the veins as a result of the surrounding suppuration, and he was probably right.

It must be particularly denied that thrombophlebitis of the small veins within the peritonsillar tissue and within the parapharyngeal space often grows into the jugular vein producing thrombophlebitis. This conception is contrary to the general experience that a thrombus seldom grows from small veins into larger veins, and, indeed, it may be said that, in general, thrombophlebitis of the small veins surrounding the tonsil often occurs without producing an infection of the blood stream and furthermore that thrombophlebitis of the internal jugular vein is not common in deep infections of the neck. Summarizing the cases of

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4. Sjöberg, A. A.: Contribution to the Pathogenesis of Septic Complications of Tonsils, *Acta oto-laryng.* 25:68, 1937.



Waldapfel<sup>5</sup> and of Beck<sup>6</sup> and those observed by my associates and me, there are 85 cases of deep infections of the neck, in but 8 of which (about 9 per cent) has thrombophlebitis of the internal jugular vein appeared.

When the infection has penetrated into the parapharyngeal space it first affects the anterior compartment, since this part of the parapharyngeal space lies closest to the mucous membrane. On the virulence of the bacteria, on the resistance of the patient and probably on the individual variability in structure of the superior constrictor muscle and the connective tissue depend the further changes within the parapharyngeal space. However, it might be said that slight infections of the parapharyngeal space occur more often than is usually assumed, particularly after inflammatory diseases of the tonsils. Furthermore, it is possible that in instances of apparent focal infection coming from the tonsils the focal infection originates not within the tonsil but within the parapharyngeal space. Aside from the more or less chronic inflammatory diseases of the parapharyngeal space, one has to consider the changes following acute inflammations of the mucous membrane of the pharynx.

First of all lymphadenitis practically always accompanies acute tonsillitis and peritonsillitis. Under circumstances not exactly known it is possible that the infected glands which are adjacent to the internal jugular vein infect the vein before actual suppuration occurs within the parapharyngeal space or within the glands. The infection of the wall of the vein may or may not be followed by the development of a thrombus. At any rate, it is possible for sepsis to develop soon after the onset of angina and the condition is called, therefore, "fulminant sepsis after angina." Such cases have been studied particularly by Goodman<sup>7</sup> and Waldapfel,<sup>8</sup> but as early as 1912 Ruttin<sup>9</sup> observed a similar pathologic picture in a case in which a cervical gland infected from otitis media infected the jugular vein and thus the clinical features imitated those of sinus thrombosis.

The pathologic picture in such cases is rarely conspicuous, and I wish to emphasize that one sometimes observes cases of fulminant

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5. Waldapfel, R.: Die postanginöse Pyämie, *Ztschr. f. Hals-, Nasen- u. Ohrenh.* **23**:178, 1929.

6. Beck, A. L.: Study of Twenty-Four Cases of Neck Infection, *Tr. Am. Acad. Ophth.* **37**:342, 1932.

7. Goodman, C.: Primary Jugular Thrombosis Due to Tonsil Infection, *Ann. Otol., Rhin. & Laryng.* **26**:527, 1917.

8. Waldapfel, R.: Ein weiterer Beitrag zur Pathogenese der postanginösen Pyämie, *Ztschr. f. Hals-, Nasen- u. Ohrenh.* **26**:429, 1930; *Zur Klinik und Therapie der Sepsis nach Angina*, *Wien. klin. Wchnschr.* **40**:136, 1935.

9. Ruttin, E.: Otitische lymphadenogene Septicopyämie, *Beitr. z. Anat., Physiol., Path. u. Therap. d. Ohres* **5**:40, 1912.

sepsis after angina in which a marked pathologic picture cannot be discovered even on autopsy. In general, however, the condition is not frequent, as Shapiro<sup>10</sup> pointed out in discussing the cases of Günther,<sup>11</sup> Dean<sup>12</sup> and Barnhill<sup>13</sup>. My associates and I observed 4 cases of fulminant sepsis after inflammatory diseases of the mucous membrane of the pharynx. In one of these cases the condition was accompanied by agranulocytosis; another was interesting because of the appearance of a heart block of short duration.

CASE 2.<sup>14</sup>—R. G., a white man 44 years old, had previously had frequent sore throats. Two weeks before his admission to the hospital he again became ill with a sore throat, particularly on the right side. He went to bed, and after three days he felt better. On the evening of that day, however, he again felt

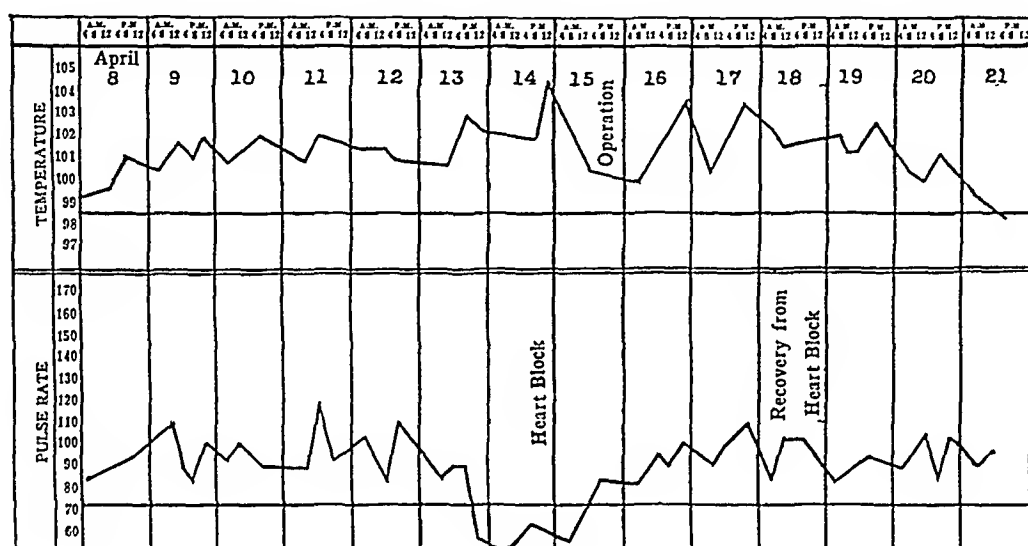


Fig. 5 (case 2).—Chart of the temperature and pulse rate.

pain in the throat; he could not swallow and had fever and a stiff neck. The pain became progressively worse, and swelling developed on the right side of the neck.

When he was admitted on April 8, 1939, he gave the impression of an ill man. Over the right side of the neck extending from the right angle of the jaw, 3 inches (7.6 cm.) of the way down along the anterior border of the

10. Shapiro, S. L.: Deep Cervical Infection Following Tonsillectomy, *Arch. Otolaryng.* **11**:701 (June) 1930.

11. Günther, K.: Vier Jahre Tonsillektomie an der Würzburger Universitäts Klinik, *Ztschr. f. Laryng., Rhin.* **17**:191, 1928.

12. Dean, L. W.: Severe Sepsis Following Tonsil Operations, *Laryngoscope* **20**:739, 1910.

13. Barnhill, in discussion on Glogau, O.: Abscesses Descending from the Upper Air Passages into the Neck and Mediastinum, *Tr. Am. Acad. Ophth.* **27**:393, 1922.

14. Case 2 was observed in the otorhinolaryngologic department of the University of Illinois. Dr. F. Lederer, head of the department, permitted me to publish it.

sternocleidomastoid muscle, there was an indurated, somewhat swollen mass, which displaced the larynx to the left. The pharynx was red and injected. Just above the right piriform sinus was a boggy whitish mass, which hung over the larynx. Breathing was not obstructed. The erythrocyte count was 4,900,000, with 85 per cent hemoglobin; the leukocyte count, 16,700, with 10 per cent lymphocytes, 3 per cent monocytes and 87 per cent neutrophils. On April 11 the leukocyte count was 14,700, with 11 per cent lymphocytes, 4 per cent monocytes and 85 per cent neutrophils. The patient received high voltage roentgen therapy and sulfanilamide and felt better. On April 14 the leukocyte count was 12,000. Both piriform sinuses were filled with pus and mucus; the cords were normal. There were no bacteria in the blood. The electrocardiogram showed left ventricular preponderance and complete auriculoventricular block with sinus arrhythmia. The QRS complex was wide and markedly slurred in all leads; the ST interval in leads I, II, III and IV, elevated; the T wave, prominent in all leads, especially in leads II and IV. Nodal arrhythmia, complete heart block and bundle branch block of the common type, probably on the basis of vagal pressure, were noted (fig. 5).

On April 15 an operation was performed. An incision was made along the anterior border of the sternocleidomastoid muscle. The internal jugular vein was exposed from the level of the cricoid cartilage to the digastric muscle. A large inflamed lymph node was found lying over the internal jugular vein and the common facial vein. It was removed. The wall of the anterior facial vein was whitish, in contrast with the blue walls of other veins. The vein was resected. A thrombus was not found within it. The anterior compartment of the right pharyngomaxillary space was opened, but pus was not found. The microscopic examination of the lymph node revealed chronic inflammation; the examination of the vein, thickening of the wall due to chronic inflammation. On April 16 the patient felt fairly well but complained of difficulty in swallowing. The electrocardiogram showed the S-T interval in leads I and II less elevated, the PR element prolonged,  $T_1$  low,  $T_2$  isoelectric and  $T_3$  inverted. The heart block had then become merely a first degree heart block; otherwise the electrocardiogram was normal, indicating a release of vagal pressure. On April 18 septic arthritis of the left knee developed. The knee was aspirated, and 25 cc. of opalescent, thick, somewhat cloudy but sterile fluid was removed. The electrocardiogram showed tachycardia. The P wave in leads I and III was high and sharp,  $P_4$  inverted and  $T_4$  low and diphasic. The normal electrocardiogram indicated the complete release of vagal pressure. From then on recovery was uneventful.

The case is typical. The sepsis set in three or four days after the beginning of his angina and was characterized by a general downward course, moderate leukocytosis, fever and metastasis. The pathologic picture found at operation was not conspicuous—a large lymph node adjacent to the vein, chronic inflammation of the wall of the vein and edema of the surrounding tissue, in other words, a finding typical of fulminant sepsis. In spite of this inconspicuous pathologic picture rapid recovery followed the operation.

The heart block, found at the climax of the sepsis, was explained by vagal pressure. According to the findings during operation one

rather has to consider septic inflammation of the vagal nerve causing the heart block.

In contrast to fulminant sepsis is slowly progressive suppuration of the connective tissue, the lymph channels and the lymph glands within the parapharyngeal space, the "abscesses of the parapharyngeal space," particularly studied by Waldapfel.<sup>15</sup> The suppuration is so slowly progressive that the abscess may reach an enormous size and be surrounded by a thick capsule, which is, as a rule, densely infiltrated by polymorphonuclear leukocytes and consists of connective tissue, part of which has undergone hyaline degeneration, and of muscle tissue. My associates and I observed 12 abscesses of the parapharyngeal space.

When the infection has a higher degree of virulence "phlegmon of the parapharyngeal space" develops instead of an abscess, as first described in 1920 by Mosher.<sup>16</sup> My associates and I observed 5<sup>17</sup> such cases. In cases of this type purulent necrosis of connective tissue often takes place, with development of but little pus. The great danger of the phlegmon is that it may spread within the connective tissue spaces and affect the veins, particularly the internal jugular vein, with subsequent sepsis, as pointed out by Mosher.

The propagation of the phlegmon chiefly takes place in the following directions:

(a) The phlegmon penetrates from the anterior compartment into the posterior compartment of the parapharyngeal space and spreads downward along the sheath of the blood vessels, resulting in thrombosis of the jugular vein, mediastinitis, edema of the larynx, pleuritis and metastases.

(b) The phlegmon penetrates from the anterior compartment into the posterior compartment and spreads upward along the sheath of the blood vessels, resulting in one or all of the following conditions: erosion of the internal carotid artery, phlebitis of the cavernous sinus, meningitis and abscess of the brain.

(c) The phlegmon spreads from the anterior compartment along the styloglossal muscle, resulting in phlegmon of the floor of the mouth and possibly, though rarely, osteomyelitis of the mandible.

It must be admitted that the infection spreads, as a rule, from the anterior compartment in more than one direction. Nevertheless, it is advisable from a clinical point of view to keep the foregoing division

15. Waldapfel, R.: Parapharyngeale Lymphdrüsenabscesse nach Angina, *Pract. oto-rhino-laryng.* **2**:69, 1939.

16. Mosher, H. P.: Deep Cervical Abscess and Thrombosis of the Internal Jugular Vein, *Laryngoscope* **30**:365, 1920.

17. The sum of the cases observed by my associates and me is 21 and not 20 because 1 case is mentioned twice since the patient once had an abscess of the parapharyngeal space and at another time fulminant sepsis.

in mind, particularly the differentiation between fulminant sepsis, abscess and phlegmon. The following case, in which an abscess and fulminant sepsis originated in the pharynx, shows the importance of the described division.

CASE 3.—K. P., a man 55 years old, suffered from polyarthritis for one year. On May 30, 1933, he suddenly became ill, with a high temperature and chills. At the same time the rheumatic pain disappeared. On June 3 there was a swelling at the angle of the right side of the jaw as large as a pigeon's egg. The swelling was firm, slightly tender and movable. Speech was indistinct, but there was no hoarseness. The temperature was normal. The right vallecula and the right half of the epiglottis were covered by necrotic tissue. The right pharyngoepiglottic fold, the right half of the epiglottis and the right aryepiglottic fold were swollen. The Wassermann reaction of the blood was negative. The leukocyte count was 7,500, with 45 per cent neutrophils, 4 per cent juvenile forms, 27 per cent lymphocytes, 8 per cent monocytes, 6 per cent metamyelocytes and 10 per cent myelocytes. The sputum did not contain Koch's bacilli. The temperature on the evening of June 9 was 99.5 F. The necrotic tissue disappeared. There was a deep ulcer with smooth walls and sharp margins between the tongue and the pharyngoepiglottic fold on the right side. The temperature on June 12 was 98.2 F.; on June 17, 98.7 F. The ulcer at the base of tongue was smaller. The swelling at the angle of the jaw increased and was firm, indolent and but little movable. On June 21 a specimen was taken for biopsy from the margins of the ulcer, which showed edema and chronic inflammation. No polymorphonuclear cells could be found in the section, but some lymphatic follicles were present. The temperature on June 23 was normal. The swelling at the angle of the jaw increased. On June 24 incision of the swelling revealed a large abscess with a thick capsule consisting of hyaline connective tissue, muscle tissue and many polymorphonuclear cells. An uneventful recovery occurred. On November 9, 1933, the patient suddenly became ill again, with fever and general malaise. On November 10 he was drowsy and vomited three times. At noon he was unconscious. During the night of the tenth the temperature was 105.6 F. and the pulse rate 88. Meningeal symptoms could not be found; the ears were normal. Both palatoglossal arches were red, the right more than the left. In the superior part of the right palatoglossal arch circumscribed edema and hemorrhage were seen. The lateral wall of the pharynx on the right side and the entire lingual surface of the epiglottis were red, as in erysipelas of the pharynx. The epipharynx was normal, as were the lungs, spleen, eyegrounds and cerebrospinal fluid. The scar on the right side of the neck was red and little swollen. On November 11, the temperature was 104.2 F.; the pulse rate, 110. The leukocyte count was 2,000. A smear revealed only small and old lymphocytes. On November 12 the patient died.

At autopsy edema of the base of the tongue, of the mucous membrane of the pharynx and of the aryepiglottic folds, swelling of the lymph glands on the right side of the neck and acute tonsillitis were noted. The jugular vein was normal. Microscopically I observed many necrotic areas in the mucous membrane of the base of the tongue and in that of the pharynx. In the region of the vallecula there were many subepithelial blood vessels filled with plugs of streptococci. The surrounding tissue, however, was but little changed. The tonsils were atrophic, and their lymphatic tissue was normal; the adjacent muscles of the pharynx also were normal. Some plugs of streptococci were found within the capillaries in the peritonsillar tissue.

The patient primarily had a large abscess in the parapharyngeal space following an inflammatory disease of unknown origin in the base of the tongue. The abscess developed with but few general symptoms, as such abscesses always do. However, the blood count was surprising even at that time. Usually one finds in such cases either a normal blood count or slight leukocytosis. In this case there was slight leukopenia, with a great amount of immature marrow cells (6 per cent metamyelocytes and 10 per cent myelocytes) and without eosinophils. Although I did not know the blood count of the patient under normal circumstances, it must be said that the quoted blood count signaled a disturbance either in the development of the polymorphonuclear cells within the marrow or in the effusion of the polymorphonuclear cells from the marrow into the blood stream. This finding makes it, however, more clearly understood why four months after the first recovery the patient again became ill with acute pharyngitis combined with typical granulocytopenia.

#### SYMPTOMATOLOGY

The symptoms of the inflammatory diseases of the parapharyngeal space are dependent (1) on the localization and (2) on the nature of the inflammation. In general one can differentiate between two kinds of symptoms: (*a*) general symptoms and (*b*) local symptoms. The local symptoms, which are more marked the more slowly the inflammation progresses within the parapharyngeal space (Wessely),<sup>18</sup> can be divided into (1) organic symptoms and (2) mechanical symptoms.

Looking on the three different kinds of inflammatory disease within the parapharyngeal space, one finds these clinical entities: In instances of fulminant sepsis the general symptoms are in the foreground, viz., septic fever and chills and later enlargement of the spleen and jaundice. Of great importance in such cases are the findings in the blood. First, the absolute number of leukocytes is important. Various findings will be noted. There are cases in which marked leukocytosis occurs (according to Shapiro<sup>10</sup> up to 20,000), but there are also cases in which the condition is combined with leukopenia and even with granulocytopenia, like case 3 of the present series. Waldapfel<sup>19</sup> pointed out that the conditions combined with leukopenia have, as a rule, a bad prognosis. Furthermore the eosinophils are of importance, since the prognosis improves when these cells appear within the blood stream, a good sign in all cases of sepsis, as is well known.

Beside these general symptoms, the local symptoms are of less importance. It is true that slight swelling of the glands is seen at the

18. Wessely, E.: Die endokraniellen Komplikationen nach Tonsillitis und Peritonsillitis, Eine klinische Studie, *Monatschr. f. Ohrenh.* **66**:1190, 1932.

19. Waldapfel, R.: Ueber Leukopenie bei pharyngogener Sepsis, *Monatschr. f. Ohrenh.* **69**:1178, 1935.

angle of the jaw and along the jugular vein, but similar findings will be obtained with ordinary peritonsillitis. However, a complication must be suspected when the jugular vein is tender along its entire course or can be felt as a firm cord. But such findings are seldom obtained in cases of this type.

It is true even now that poverty of local symptoms explains the frequent errors in the diagnosis of such cases. Usually the condition is mistaken for pneumonia, typhoid fever or acute arthritis. Therefore, it must be kept in mind that in every case of angina an inflammatory disease of the parapharyngeal space is to be suspected, particularly of the jugular vein when the fever has not disappeared within three or four days or when chills are observed during that time. That is particularly true when fever or chills are observed and the inflammation of the tonsils has more or less disappeared. Mosher<sup>10</sup> emphasized this point.

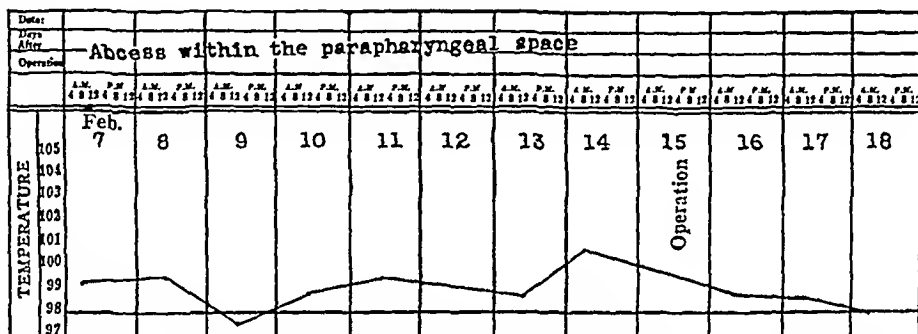


Fig. 6.—Abscess within the parapharyngeal space; temperature chart.

I wish to mention the following case as typical:

CASE 4.—F. K., a man 40 years old, on June 2, 1934, became ill with a follicular angina. On June 6, the angina was subsiding, but a chill was observed. On June 7 the temperature was 103.8 F. Again a chill was observed. In the upper part of the jugular vein a swollen gland was palpable. The tonsils were removed. On June 8 the temperature was again 103.8 F. The leukocyte count was 19,100, with 65 per cent polymorphonuclear cells, 4 per cent juvenile forms, 23 per cent lymphocytes, 7 per cent monocytes and 1 per cent myelocytes. The vessel sheath was opened, and an inflamed gland was found adjacent to the internal jugular vein. There was no pus within the parapharyngeal space. An uneventful recovery occurred.

General symptoms are of less importance with abscesses of the parapharyngeal space than with fulminant sepsis. Chills are rarely present, and the temperature rises but little, to about 100.4 F. (fig. 6). Accordingly, signs of general sepsis seldom appear in such cases. Only with more progressive conditions are there higher temperatures, moderate leukocytosis (often without shifting to the left) and some-

times signs of disease of the kidneys. The general symptoms, of course, increase rapidly when the abscess perforates its capsule and spreads into the connective tissue of the parapharyngeal space.

However, in such cases the local symptoms, primarily the mechanical symptoms, are marked. Most striking is the swelling at the angle of the jaw. Here is found a firm, little movable, indolent swelling covered with normal skin. This swelling grows relatively fast and may reach the size of a fist. Since such abscesses, as mentioned earlier in this paper, are covered with a thick capsule, fluctuation as a rule is missed, as Mosher,<sup>20</sup> Hall<sup>2</sup> and Waldapfel<sup>15</sup> have pointed out. The swelling rather gives the impression of a glandular tumor. Against this diagnosis, however, is the relatively rapid growth of the swelling in a not very ill patient. Sometimes these abscesses feign the aspect of woody phlegmon. It is understood that such swellings may produce a reduction of the movements of the head.

The abscesses do not grow only from within outward; they also grow inward and may extend upward along the vertebral column. As a result of that direction of growth, the tonsils and the lateral wall of the pharynx may bulge inward (prolapse of the tonsils and palatal arch, Beck<sup>6</sup>), and the palatopharyngeal arch and the aryepiglottic folds may become edematous, so that marked difficulties in swallowing are noted. Finally a moderate degree of trismus is produced in such cases, as Shapiro<sup>10</sup> pointed out, by inflammation of the internal pterygoid muscle and the pterygomandibular ligament (Uffenorde<sup>21</sup>).

Wessely<sup>18</sup> referred to the fact that the trismus sometimes may disappear without change in the other local symptoms and without spontaneous rupture of the abscess. This finding ought to signify the penetration of a peritonsillar abscess into the parapharyngeal space. My associates and I could observe the same finding in 1 of our cases, but we do not agree with Wessely's explanation of this finding. As our case taught us, the disappearance of the trismus without improvement of the general and local symptoms does not always signalize perforation of the superior constrictor muscle of the pharynx, but sometimes large destruction of the internal pterygoid muscle.

When the abscess develops in the upper portion of the anterior compartment or when it extends into that area, organic symptoms are added to the mechanical symptoms just mentioned. These organic symptoms originate particularly in the trigeminal nerve. The patients

20. Mosher, H. P.: The Submaxillary Fossa Approach to Deep Pus in the Neck, *Tr. Am. Acad. Ophth.* **34**:19, 1929.

21. Uffenorde, W.: Die vom Schlunde ausgehenden septischen Allgemeinerkrankungen mit makroskopischen und mikroskopischen Demonstrationen, in *Premier Congrès international d'oto-rhino-laryngologie*, Copenhagen, Th. Linds Efterfølger, 1928, p. 3.



complain of pain in the teeth and of headache, which radiates to the temporal area, to the ear or to the occiput. I call particular attention to the last mentioned symptom, because some writers explain the headache as a manifestation of basilar meningitis. According to the experience of my associates and me, this explanation is not quite right. We ascribe it to a disease of the auriculotemporal nerve, which leaves the third branch of the trigeminus just below the foramen ovale.

In order to demonstrate the symptoms of such abscesses I describe the following case, which was long observed and which shows what happens when such a condition is not recognized for a long period.

CASE 5.—Mr. P., 49 years old, on Jan. 19, 1933, became ill with a sore throat and a chill. He did not take his temperature. On January 23 he was better. On January 25 he again had a sore throat and a chill. Again the temperature was not taken. A few days later an incision was made within the throat, after which improvement was noticed. But a few days later he again noticed pain in swallowing and an increasing swelling at the angle of the right jaw. On February 7 he had a septic appearance. However, the temperature was 99.1 F. There was a marked swelling at the angle of the right jaw and slight trismus. The right tonsil was pushed forward toward the middle line, the palatopharyngeal arch, the lateral wall of the pharynx and the right aryepiglottic fold were swollen. An incision of the lateral wall of the pharynx did not reveal any pus. On February 8 the temperature was 99. The displacement of the tonsil, the edema within the pharynx and the swelling at the jaw increased, but not the trismus. On February 9 the temperature was 96.8 F.; the leukocyte count, 14,900, with 87 per cent polymorphonuclear cells, 8 per cent lymphocytes and 5 per cent monocytes. In the urine albumin and casts were found. On February 11 the temperature was 99.3 F.; the erythrocyte count, 4,200,000; the Sahli reaction, 78 (87 per cent); the color index, 1.04, and the leukocyte count, 17,000, with 83 per cent polymorphonuclear cells, 1 per cent juvenile forms, 10 per cent lymphocytes and 6 per cent monocytes. Incision of the right palatoglossal arch revealed but little pus. On February 13 the temperature was 98.7 F. The swelling within the pharynx and at the jaw increased. There was some shortness of breath. On February 14 the temperature rose to 100.4 F. There was typical woody phlegmon on the right side of the neck but no fluctuation and no trismus. On February 15 the temperature was 99.7 F. The patient appeared septic. The leukocyte count was 13,500, with 80 per cent polymorphonuclear cells, 11.5 per cent lymphocytes and 8.5 per cent monocytes. Therefore, a prophylactic mediastinotomy was performed, and a large abscess within the right parapharyngeal space was drained. The abscess extended into the prevertebral space. In the pus streptococci were found. Uneventful recovery ensued.

When such abscesses reach a certain size they may perforate spontaneously. Beck<sup>6</sup> described a case in which the abscess perforated into the external auditory canal. In 1 of the cases observed by my associates and me a similar, but not identical, condition was met. We observed another case in which the abscess perforated through the tonsil into the mouth. In this case, indeed, the patient had carcinoma of the tonsil with secondary infection of the parapharyngeal space.

CASE 6.—R. P., a man 50 years old, had had syphilis twenty years before. In March 1937 he noticed pain in swallowing and a swelling at the angle of the left jaw. Catarrh of the pharynx was diagnosed and treated. The swelling at the jaw, however, remained. In April 1937 angina developed, with a temperature of 100.4 F. After one week he recovered. On Aug. 13, 1937, he again noticed pain on swallowing and suddenly the swelling at the angle of the left jaw increased to the size of an apple. Moreover, he noticed pain radiating into the left ear, but no fever was observed. Since the Wassermann test was positive, his syphilis was treated with 1 cc. of a suspension of bismuth salicylate in olive oil (bismogenol) twice and 0.45 cc. of neoarsphenamine three times. During the following days, the swelling at the jaw increased, and marked trismus developed. On August 26 he suddenly expectorated much blood and pus, and the swelling decreased. On September 13 a slightly tender, immovable gland was found at the angle of the left jaw; furthermore, a large ulcer on the left palatoglossal arch and another large purulent ulcer on the left tonsil were discovered. A biopsy of a specimen from the ulcer on the tonsil revealed chronically inflamed (gummatous?) tissue but no signs of malignancy. He was treated with iodine. On September 22 the conditions were markedly improved. The ulcer on the tonsil was clean, the glands diminished and the trismus improved. He again received antisyphilitic treatment. On Jan. 1, 1938, the swelling at the jaw was again markedly increased, and he again noticed pain on swallowing. A few days later he again expectorated blood and pus, and on January 10 the pain on swallowing and the swelling at the jaw disappeared. On January 3 a large ulcer on the left tonsil was found. The ulcer destroyed the entire palatoglossal arch, extending forward to the ascending branch of the mandible and upward into the soft palate. The ulcer had perforated through the superior constrictor muscle. Glands were not found at the angle of the jaw. A second biopsy revealed nonhornifying squamous cell carcinoma. He was given a Coutard treatment with roentgen rays. After a short period of improvement, he died in May 1938 of cachexia.

Such spontaneous perforations of abscesses within the parapharyngeal space are not frequent. Certainly the laryngologist should not rely on them, as it is more common for the abscesses to perforate into the prevertebral space or into the posterior compartment than into the mouth or through the skin.

As far as the clinical aspect is concerned, phlegmon lies between fulminant sepsis and abscess within the parapharyngeal space. When it develops typically it is characterized by general symptoms as well as by local symptoms. As far as the general symptoms are concerned, high temperature and chills occur (fig. 7). Nevertheless there are exceptions in that sometimes phlegmon of the parapharyngeal space may set in with a critical downfall of temperature signaling a collapse of the circulatory system. Orton<sup>22</sup> described such cases, and my associates and I also have seen such cases. Accordingly, as in cases of sepsis from other origins, the sepsis with collapse temperature has a bad prognosis.

22. Orton, H. B.: Deep Infections of the Neck. *Ann. Otol., Rhin. & Laryng.* 47:48, 1938.

As far as the findings in the blood are concerned, I have to repeat what I said regarding fulminant sepsis. My associates and I did not observe, however, a case of phlegmon with granulocytopenia. Other general symptoms are yellow discoloration of the sclera, disease of the kidneys, swelling of the spleen, septic edema of the larynx, edema of the brain and, finally, metastases.

At the beginning of the disease the local symptoms are of course not so marked as in the instance of an abscess. Nevertheless, swelling at the angle of the jaw, trismus and sometimes swelling in the region of the parotid gland may be found early. The local symptoms, however, increase, as a rule, when the phlegmon spreads into the surrounding tissue, which can occur, as was mentioned, in three directions:

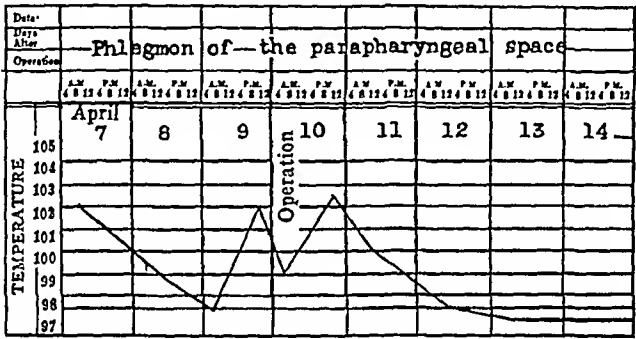


Fig. 7.—Phlegmon of the parapharyngeal space; temperature chart.

(1) along the vessel sheath, downward, (2) along the pterygoid plexus and the third branch of the trigeminus nerve, upward, and (3) along the styloglossal muscle, forward.

In the first event one finds tenderness along the jugular vein, tenderness above the clavicle and sometimes a swelling of glands along the jugular vein. Many years ago Poulson<sup>23</sup> emphasized that in such cases the pus seldom penetrates into the mediastinum, which corresponds with what my associates and I observed. Waldapfel,<sup>5</sup> however, found among 44 cases 13 instances (29 per cent) of mediastinitis. Pearse<sup>24</sup> found that gravitation of pus from the neck causes only one fifth of the cases of suppurative mediastinitis; in this group, however, are found many of the more dangerous infections from esophageal perforations.

23. Poulson, K.: Ueber Abscesse am Halse, Deutsche Ztschr. f. Chir. **37**:55, 1893.

24. Pearse, H. E.: Mediastinitis Following Cervical Suppuration, Ann. Surg. **108**:588, 1938.

In the second event there are typical pain in the teeth, headache and a feeling of obstruction of the ears, due to acute serous catarrh of the middle ear. Wessely<sup>18</sup> in 3 of his cases observed typical neuralgia of the trigeminus nerve. I wish to repeat that from the headache per se one should not conclude that basilar meningitis exists. I<sup>25</sup> have previously described a case which belongs in this group.

In the third case phlegmon of the floor of the mouth developed with swelling of the skin, as well as swelling of the mucous membrane at the floor of the mouth. I<sup>26</sup> observed a case of this kind.

CASE 7.—B. F., 45 years old, with a history of frequent sore throat, became ill on April 19, 1936, with fever and difficulty in swallowing. On April 20 the difficulty increased, and the temperature rose to 104 F. No chill was observed. The diagnosis of acute pharyngitis and follicular angina was made. There were no swollen glands at the angle of the jaw. In the evening the patient had a temperature of 102.2 F. but no chill. On April 21 the temperature decreased. On April 22 the temperature again rose to 102.2 F. No chill was observed, but there was some shortness of breath. A thorough examination revealed a septic color of the face, euphoria, cyanosis and a swelling at the angle of the left jaw as large as a fist. The swelling extended into the submental region, and at the angle of the right jaw there were some enlarged glands but not as marked as on the left side. Fluctuation could not be found. The left vessel sheath was tender. There was tenderness above the clavicles. The tip of the tongue was elevated toward the hard palate. The floor of the mouth below the tip of the tongue was swollen and red. There were plugs of pus at the opening of the left submaxillary duct. Both palatoglossal arches were swollen but not markedly red. The mucous membrane of the hypopharynx was edematous. The epiglottis was edematous and showed on its laryngeal surface a small ulcer. The vocal cords could not be seen. The left palatoglossal arch was incised. Pus was not found. On April 23 the temperature rose to 102.7 F. without a chill. An external operation was planned. After the incision of the skin the patient suddenly died.

The observations at autopsy were typical of sepsis. The microscopic examination of the floor of the mouth revealed phlegmon with the production of but little pus and much necrosis. The phlegmon originated within the left parapharyngeal space after follicular angina, traveled, in the form of a horseshoe with the convexity toward the spina mentalis, through the floor of the mouth and broke spontaneously into the mouth in the region of the right vallecula. The phlegmon passed the midline within the transverse space between the geniohyoid and genioglossal muscles.

It would, of course, be wrong to believe that phlegmon always spreads in one of the three directions mentioned. On the contrary, one must suppose that it usually spreads in more than one direction.

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25. Brunner, H.: Brain and Meningeal Symptoms of Pharyngeal Origin, *Ann. Otol., Rhin. & Laryng.* **48**:259, 1939.

26. Brunner, H.: Ueber einen Fall von Mundbodenphlegmone nach Angina follicularis, *Monatschr. f. Ohrenh.* **10**:1436, 1936.

However, one direction is always the chief direction. This fact will be demonstrated by the following case:

CASE 8.—D. S., 56 years old, became ill on April 6, 1937, with fever and sore throat. On April 7 spontaneous rupture of a peritonsillar abscess on the right side was noticed. After the rupture the patient had two chills. On April 8 the temperature decreased. The abscess drained well, but she again noticed one chill. On April 9 the temperature was 97.5 F. in the morning and 102.2 F. in the evening, when she again had two chills. On April 10 I saw her for the first time. She did not look septic. Her temperature was 99.3 F. There was swelling at the angle of the right side of the jaw, slight tenderness of the right jugular vein, headache, pain in the teeth on the right side and moderate trismus. The right tonsil was draining well from the upper lacuna. The leukocyte count was 8,350, with 75 per cent polymorphonuclears, 5 per cent juvenile forms, 4 per cent monocytes, 15 per cent lymphocytes and 1 per cent eosinophils. In the evening the temperature rose to 102.6 F. Therefore, the vessel sheath was exposed, and the parapharyngeal space was opened. No pus but a serohemorrhagic fluid was found within the space. Then the tonsil was removed, and a big peritonsillar abscess was drained. After the tonsillectomy a fistula was found in the inferior part of the tonsillar niche leading into the parapharyngeal space. An uneventful recovery occurred.

In this case the tenderness of the jugular vein indicated that the suppuration within the parapharyngeal space had a tendency to spread downward along the vein, while the pain in the teeth and the headache pointed to an ascending infection. Further, it should be noted that leukocytosis was not found and that even the eosinophils had not disappeared. The patient, therefore, was operated on in an early stage.

When patients with phlegmon are operated on one often finds but little pus. However there is marked hyperemia and a serohemorrhagic exudate within the tissue. When the condition has progressed, purulent necrosis of the tissue is most often found (gangrenous phlegmon)—but not much frank pus.

The symptomatology of inflammation of the parapharyngeal space given in this paper naturally is somewhat schematic, since the margins between the three kinds of inflammation I have spoken of are not as sharp as one would believe from reading this description. Nevertheless, the different kinds of inflammation within the parapharyngeal space each represent a different clinical entity, at least in the majority of instances.

#### PROGNOSIS

The prognosis is dependent (1) on the constitutional resistance of the patient, (2) on the character of the inflammation and (3) on the time when the operation is performed. Of the 4 patients with fulminant sepsis seen by my associates and me, 2 died and 2 were cured by an external operation. Of our 12 patients with abscess within the

parapharyngeal space 2 died and 10 recovered. Included with the 2 patients who died is the patient with the carcinoma of the tonsil (case 6) and the one in the following unusual case:

CASE 9.—I. H., 34 years old, had a history of frequent sore throats for many years. In 1931 his tonsils were removed. On Sept. 18, 1933, pain developed on the left side of the throat. Simultaneously he had pain on the left side of the occiput and in the teeth of the left side and trismus. Ten days after the onset of the disease a swelling on the left side of the neck appeared. The swelling was incised by a general surgeon and a little thin pus evacuated, but the temperature did not decrease. The parapharyngeal space was not opened. A few days later tender swelling at the lateral wall of the pharynx behind the niche of the left tonsil was discovered. On September 30 the parapharyngeal space was opened from the palatoglossal arch by a general surgeon. A considerable amount of pus was evacuated, and it was found that the wound within the mouth communicated with the wound in the neck. The parapharyngeal space was irrigated daily through the mouth, and a critical fall in temperature occurred. However, the patient complained of intense headache. On October 7 the temperature rose to 106 F. New incisions were made within the mouth, and the parapharyngeal space was again irrigated. The temperature slowly decreased, but the headache, particularly the pain in the temples and in the right forehead, persisted. The pain in the teeth did not abate; so a bridge between the upper teeth on the left side was removed. On January 2 some scars were found in the left palatoglossal arch. The niche of the right tonsil was empty; in the niche of the left tonsil there was a small piece of tonsillar tissue. The pharynx and larynx were otherwise normal. The diagnosis of an abscess within the right frontal lobe was made. The abscess was opened and drained on January 3. On January 18 the patient died. The autopsy revealed severe purulent pachymeningitis interna over the right cerebral hemisphere but no leptomeningitis. Suppuration was not found within the parapharyngeal space or the paranasal sinuses.

An abscess within the left parapharyngeal space followed peritonsillar phlegmon. It was clinically characterized by pain in the occiput, pain in the teeth and trismus. It was opened from the neck, but the parapharyngeal space was not entered. Therefore, the temperature did not decrease, and the lateral wall of the pharynx on the left side was pushed into the pharynx. Twelve days after the onset of the disease the parapharyngeal space was opened from the mouth only. This operation gave the patient a few days' relief, but the pain in the head and in the teeth persisted and signaled ascending infection of the parapharyngeal space. The general surgeon who operated on the patient did not realize the danger and instead of opening the parapharyngeal space radically irrigated it through the mouth. This treatment was more dangerous than helpful. (Wessely<sup>18</sup> after injecting india ink into the parapharyngeal space under low pressure found the ink at the base of the skull, in the vicinity of the foramen ovale.) Indeed, the patient seven days after the opening of the parapharyngeal space had a high temperature again, and his pain persisted and grew even worse. New incisions were made, and the parapharyngeal space was

again irrigated through the mouth. The temperature now slowly decreased, but the pain did not, and gradually neurologic symptoms developed, indicating an abscess within the right frontal lobe.

There is no doubt that the condition was a metastatic abscess of the brain originating from the inflammation within and beyond the pharyngeal wall. The fatality was, at least partially, due to the treatment. It is, of course, impossible to say that the patient could have been saved by other treatment, but one can say that the treatment administered was not the proper one.

Of the 12 patients with abscess within the parapharyngeal space seen by my associates and me, 9 had an external operation. One of these died. One patient's abscess was drained as late as one month after the disease. Despite that fact the patient recovered. For 1 patient the abscess was drained through the mouth. This abscess developed after tonsillectomy. The patient recovered. Two patients experienced spontaneous rupture of the abscess, 1 case into the external auditory canal and the other through the tonsil into the mouth. Of those 2 patients 1 died (of carcinoma of the tonsil).

Of the 5 patients with phlegmon of the parapharyngeal space 4 died. The 4 who died included 1 who died without operation, 1 who died immediately after the incision of the skin, 1 for whom the operation was undoubtedly too late, because my associates and I failed to make a diagnosis in time, and, finally, 1 in whom the sepsis, originating from the phlegmon, developed with such rapidity that even early operation could not save him.

My associates and I lost 8 of 20 patients (40 per cent). This mortality is high, since Orton<sup>22</sup> lost only 3 of 16 patients (19 per cent) and Beck<sup>6</sup> only 1 of 24 patients (4.2 per cent). The mortality in our series is surpassed, however, by that which Waldapfel<sup>5</sup> reported, for he lost 25 of 43 patients (58 per cent). The great difference can be explained when one considers that the number of fatalities rapidly increases when one has to deal with cases of fulminant sepsis or phlegmon and that the cases of Waldapfel<sup>5</sup> were observed at a time (1905) when but little was known of deep infections of the neck. From our experience I reach the conclusion that of all inflammatory diseases of the parapharyngeal space the abscesses have by far the best prognosis.

#### TREATMENT.

The inflammatory diseases of the parapharyngeal space must be treated surgically. I admit that abscesses of the parapharyngeal space may heal by spontaneous rupture. However one never knows if that will happen. Therefore, even with abscesses operation is indicated.

The first question which arises is whether an endoral or an external operation should be performed. In cases of fulminant sepsis and of typical phlegmon there can be little doubt. In such cases only the external approach can be considered. However, one meets another situation when abscesses are concerned. In such cases the surgeon's decision is dependant on the intensity of general symptoms and the size of the abscess. One cannot expect an abscess which is accompanied by marked general symptoms or which produces enormous swelling on the outside of the neck to heal after an endoral operation alone. In such cases the external operation has to be performed. In abscesses, however, which have not progressed far, an endoral approach is surely justified. The endoral operation should be performed in such a manner that the superior constrictor muscle is perforated. It will, as a rule, be necessary to remove the tonsil, since one has to consider the tonsil as a tampon which hinders the adequate evacuation of pus from the parapharyngeal space into the mouth.

As far as the external approach is concerned, Waldapfel<sup>5</sup> made it clear that the surgeon primarily should drain the abscess within the parapharyngeal space, the operation on the blood vessels being of secondary importance. In connection with the external operation the question of anesthesia has to be considered. This is a difficult problem when one has to deal with severe sepsis. Local anesthesia with procaine hydrochloride in such cases is dangerous, as Waldapfel pointed out. I saw a patient who died immediately after the local anesthetic was injected (case 7). Likewise rectal anesthesia induced by avertin with amylene hydrate is dangerous for patients who suffer from inflammatory disease of the upper respiratory tract. Finally, in 2 cases reported by Wassmund<sup>27</sup> respiration stopped immediately after the slow intravenous injection of 3 to 4 cc. of evipansodium. In 1 of these cases a large abscess within the submaxillary space, and in the other an abscess within the parapharyngeal space, was observed. General anesthesia with ether is apparently the best method, provided that the mucous membrane of the upper respiratory tract is not inflamed. A few years ago I advised bolstering the circulation of the blood with heart stimulants and with blood transfusions before operation in cases of severe sepsis. Naturally this advice cannot be followed when the operation has to be performed in an emergency.

The incision of the skin can be made either along the horizontal branch of the mandible or along the anterior border of the sternocleidomastoid muscle. My associates and I prefer the latter incision for two reasons. First, this incision avoids the marginal branch of the

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27. Wassmund, M.: *Lehrbuch der praktischen Chirurgie des Mundes und der Kiefer*, Leipzig, 1935.



facial nerve, which runs along the inferior border of the mandible, and, second, the incision can easily be prolonged if the surgical findings demand thorough exposure of the vessel sheath. In cases in which an abscess develops within the inferior part of the parapharyngeal space elevation of the sternocleidomastoid muscle, as a rule, is sufficient to drain the abscess and the parapharyngeal space. However, one meets another situation in cases of phlegmon and in cases of abscess which develops within the superior part of the parapharyngeal space. In these cases the parapharyngeal space has to be drained from the stylomandibular ligament. This operation is simple if the anatomic conditions are not obscured by swelling of the lymphatics and edema of the connective tissue. The stylomandibular ligament, situated between the parotid glands and the submaxillary gland, must be perforated by a dilator, which is forcefully introduced into the parapharyngeal space in the direction to the tip of the nose.

If the anatomic situation is not easily recognized it is advisable to incise the superficial fascia of the neck and to expose the posterior belly of the digastric muscle. The muscle is followed to its tendon, which can easily be located where it perforates the stylohyoid muscle. Above the muscles the parapharyngeal space can be entered. One can simplify the operation by retracting the submaxillary gland forward in the direction of the submental spine, which will remove the external maxillary artery from the surgical field. However, it is rarely necessary to elevate the submaxillary gland with its capsule as Mosher<sup>26</sup> recommends, as the submaxillary gland is but seldom involved. Oral surgeons maintain that not more than 2 or 3 per cent of the acute inflammations within the submaxillary and sublingual compartments are due to the tonsils (Wassmund<sup>27</sup>). The sheath of the blood vessels must be extensively exposed in all cases in which symptoms of sepsis occur. It should not be incised, but inspected. If there are adjacent lymphatic glands, they must be removed. If, after removal of the glands, the sheath is apparently normal further exposure should not be made. If there are pathologic changes in the sheath it must be opened. Further operative procedure is dependent on the changes in the wall of the internal jugular vein. Since it is known that thrombosis of the jugular vein is, as a rule, induced by periphlebitis, one is confronted by a situation similar to that met on exposure of the sigmoid sinus, as Mosher<sup>20</sup> has emphasized. In a case of simple periphlebitis combined with fever but without chills, intermittent fever or septic symptoms, the periphlebitic focus must be thoroughly exposed without incision of the vein. If, in the course of the disease, intermittent fever, chills or septic symptoms are observed, the vein must be ligated below the diseased area, or the entire periphlebitic focus must be

removed. As in disease of the sigmoid sinus, it may happen that the wall of the vein heals with development of white scars but the endophlebitis and the thrombus remain. In such a case the clinical symptoms as well as the white (instead of blue) color of the wall of the vein can lead one to the correct diagnosis.

My associates and I have performed prophylactic mediastinotomy, but we no longer do so, for the pus seldom gravitates to the mediastinum; the patients succumb much earlier to the sepsis. When the inflamed focus is under control, gravitation of pus practically never occurs. If, during the operation, it is discovered that the phlegmon extends down to the mediastinum or near it, one should enter it, following the phlegmon. In such rare cases, however, one does not deal with "*prophylactic*" mediastinotomy.

There is not, at this time, much surgical aid for the patients in whom a phlegmon of the parapharyngeal space extends into the base of the skull.

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# OSTEOMYELITIS OF THE FRONTAL BONE

SURGICAL TREATMENT: WHICH WAY OF APPROACH IS THE BEST?

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Osteomyelitis of the frontal bone may be extraordinarily dangerous, because of the rapidity with which it spreads and the frequency with which it is followed by intracranial complications. The treatment—immediate and radical surgical intervention—should therefore be instituted automatically when the diagnosis has been made.

In most cases it originates from acute or chronic sinusitis, and the operation has, therefore, two purposes: (1) to remove all the diseased part of the bone and to drain possible deep-seated inflammation (leptomeningitis, epidural abscess or possibly abscess of the brain) and (2) to clean out and drain the sinuses from which the infection has originated.

The bone affected by osteomyelitis behaves as though it contained a malign tumor. The resection must therefore be performed in healthy tissue. It may be difficult, and is sometimes impossible, even *during* the operation to decide with certainty where the bone is healthy. *Before* the operation it is impossible to do so. A procedure must, therefore, be chosen which fulfils the conditions mentioned and at the same time gives a good cosmetic result. This is possible by the employment of the following technic:

## TECHNIC

A coronal incision is made from one ear to the other above the hair line, beginning a little in front of the upper point of attachment of the external ear. The incision is made right through the scalp, including the periosteum. There is little bleeding, as no branches of arteries of any size are to be found here, the few which bleed being ligated. The scalp covering the frontal bone is now easily reflected forward over the face by means of a napkin. In this way all the frontal bone and the adjacent parts of the parietal bone are laid bare, and a full view down to the supraorbital margins is obtained. Unrestricted access is now available for resection of the frontal bone, the frontal sinuses, the ethmoid labyrinth and, if necessary, the roof of the orbit and the lamina cribrosa. The scalp is then drawn back and fixed in its central third by means of mattress sutures or napkin clips. Large meches, soaked in dilute solution of sodium hypochlorite (Carrel-Dakin solution), and a couple of rubber drains split longitudinally are introduced under the scalp from the angles of the wound. Contra-incisions are generally made in the "shadow" of the eyebrows, though this can sometimes be avoided, as the drainage to the angles of the wound is excellent and a broad outlet to the nose has been established after resection of the ethmoid labyrinth. When the dressing is changed the whole cavity is washed out from the angles of the wound.

As the secretion gradually decreases, the drainage is reduced, and the scalp, of which only the central third was fixed immediately after the operation, is now brought more nearly into place. If napkin clips have been used, they are merely moved a little farther down on the side of the head. When the wound has healed the cicatrix is concealed by the hair. The bone gradually regenerates entirely, even after extensive resection, and the forehead becomes smooth. The cosmetic and mimetic results are shown by some of the illustrations.



Fig. 1.—Acute bilateral frontal sinusitis and osteomyelitis of the frontal bone. Most of the frontal bone on the left, most of the orbital roof and a little less of the corresponding osseous parts on the right were removed.



Fig. 2.—Acute frontal sinusitis on the left and osteitis of the frontal bone. The large frontal sinus and the adjacent part of the frontal bone were resected. The photographs show the final result.

The method was elaborated by Mygind and was first published by his assistant Hvidberg,<sup>1</sup> in 1932, later results being published by Mygind<sup>2</sup> himself.

1. Hvidberg, H.: Nouvelle technique opératoire pour les grandes ostéites frontales, *Compt. rend. Soc. franç. d'oto-rhino-laryng.* 45:50-57, 1932.

2. Mygind, S. H.: Herunklappen des Skalps bei Ostitis frontalis, *Acta oto-laryng.* 26:537, 1937.



Fig. 3.—Acute frontal sinusitis on the right, osteomyelitis of the frontal bone and epidural abscess. A piece of the frontal bone 8 by 7 cm. was resected. Examination five years later showed that the whole defect was replaced by a hard but somewhat wrinkled bone.



Fig. 4.—Acute bilateral pansinusitis. The whole of the anterior wall in the large frontal sinuses was resected.



Fig. 5.—Fracture through the squama frontalis, extending downward into the orbit and through both the frontal sinuses and the ethmoid labyrinths. Sequestrectomy, resection of the lamina cribrosa and incision of the dura were performed.

He has used the method in 13 cases of osteomyelitis of the frontal bone. Eleven patients were cured, and 2 died, but the 2 were extremely ill on admission to the hospital, 1 having hemiparesis, which indicated intracranial complications, and the other leptomeningitis. The latter died during the operation.

The frontal sinus of only 1 of the patients had been operated on before the occurrence of osteomyelitis; none of the other patients had been operated on at all, which contradicts the opinion predominant in some quarters that in most cases osteomyelitis of the frontal bone occurs after, and as a result of, surgical intervention on the frontal sinus.

Adson and Hempstead,<sup>3</sup> of the Mayo Clinic, independently of Mygind, reported in 1937 an absolutely identical procedure and they, too, were able to show excellent results. They, too, emphasized the fact that small stab wounds are quite ineffective, as they allow only limited drainage and do not permit the removal of necrotic bone. Abscess of the brain may result.

Skillern<sup>4</sup> made a large horizontal incision through the upper edge of the eyebrows toward the sides of the cranium and in this way was able to draw upward the scalp covering the forehead. The exposure of the frontal bone was, of course, excellent, but, judging from the accompanying photograph, the cosmetic and mimetic result was hardly as good as when Mygind's method is employed.

The method also afforded excellent assistance in a case of traumatic streptococcic meningitis with fracture through the squama frontalis extending downward into the orbita and through both the frontal sinuses and the ethmoid labyrinths, from which sequestrums were removed. The lamina cribrosa was also resected, and the dura was split, a muddy liquid appearing. Finally a section of the frontal bone 8 by 13 cm. was removed in this way in resecting a large osteoma ossis frontalis.

#### SUMMARY

Unrestricted access for resection of the frontal and the adjacent parts of the parietal bone, the frontal sinuses, the ethmoid labyrinth, the roof of the orbit and the lamina cribrosa is obtained by a coronal incision above the hair line, which permits reflection of the scalp covering the forehead forward over the face. The cicatrix is concealed by the hair, and, as no branches of the facial nerve and no muscles have been cut and as no tense scars are to be found on the forehead, the cosmetic and mimetic results are ideal.

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3. Adson, A. W., and Hempstead, B. E.: Osteomyelitis of Frontal Bone Resulting from Extension of Suppuration of Frontal Sinus: Surgical Treatment, *Arch. Otolaryng.* **25**:363 (April) 1937.

4. Skillern, S. R.: Osteomyelitic Invasion of the Frontal Bone Following Frontal Sinus Disease. *Ann. Otol., Rhin. & Laryng.* **48**:392, 1939.

# THE PIRIFORM SINUS

ANATOMIC AND CLINICAL OBSERVATIONS, WITH A REVIEW OF  
THE LITERATURE

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The piriform sinus, also termed recessus, or fossa, pyriformis, is occasionally described as being part of the larynx, but, since it lies outside of that organ, is, strictly speaking, part of the hypopharynx. It appears as a deep depression between the cricoid and arytenoid cartilages and the posterior surface of the thyroid cartilage on each side of the larynx. It is situated beneath the pharyngoepiglottic fold. Its mucous membrane laterally adjoins the posterior surface of the ala of the thyroid cartilage. In its anterior part is a low fold, the plica nervi laryngei superioris, which is produced by the internal branch of the superior laryngeal nerve and which runs downward and medially (fig. 1). The piriform sinus is limited above by the hyoid bone and below by the lower border of the cricoid cartilage. In many persons, especially those who are not too obese, one can see a white line running obliquely through the piriform sinus. This line marks the upper border of the thyroid cartilage (fig. 1).

One cannot see all these details on examining every larynx with the mirror but often only what is shown in figure 2. Phonation aids in bringing out further details. The plica nervi laryngei is rarely perceptible in the living subject. However, as Zuckerkandl has already pointed out, the nerve running through this fold can occasionally be seen shining through the mucosa in cachectic persons. I have, however, seen the nerve in its entire course through the piriform sinus in a number of perfectly normal patients (fig. 1). In other patients one sees only a part of the nerve (fig. 3). The superficial course of this nerve, as I shall point out later, is of interest in several respects.

Anomalies of the piriform sinus are relatively rare. One of the more common ones, if it can be called an anomaly, is the projection of the upper cornu of the thyroid cartilage into the piriform sinus. In such cases one sees a rounded prominence, which is hard to the touch (fig. 4). It does not cause any symptoms. On a few occasions I have seen folds in the piriform sinus which might be attributable to retarded development (fig. 5). Sometimes a fractured hyoid bone projects into

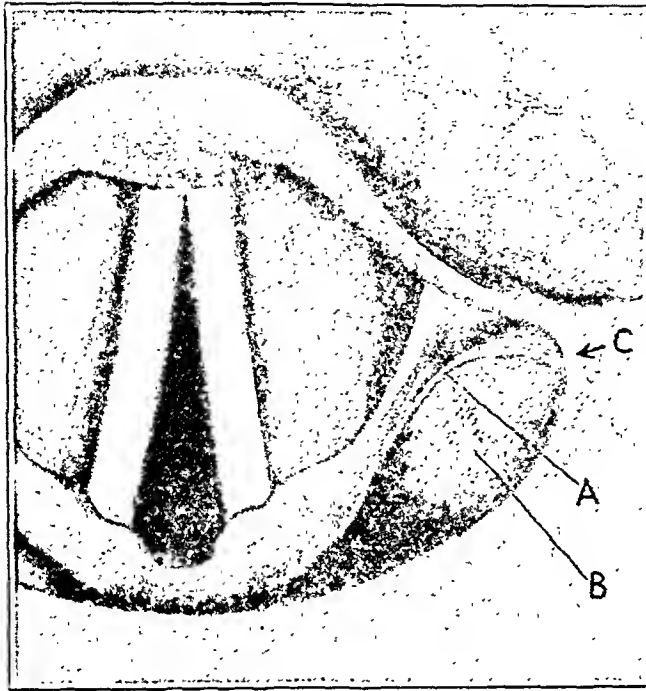


Fig. 1.—Left piriform sinus. *A* indicates the superior laryngeal nerve; *B*, the white line marking the upper border of the thyroid cartilage, and *C*, the pharyngoepiglottic fold.

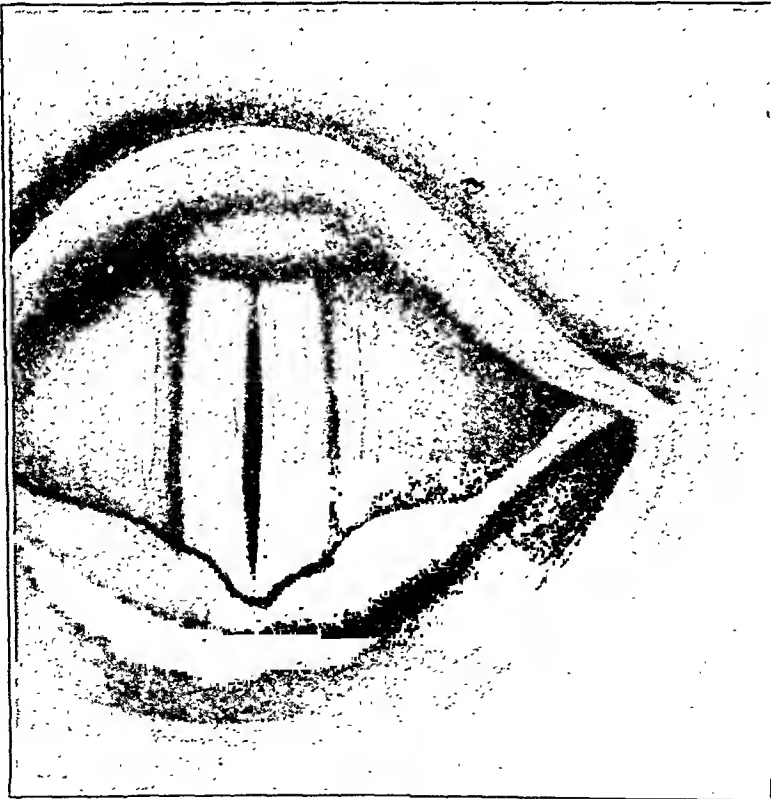


Fig. 2.—Left piriform sinus, showing no details.



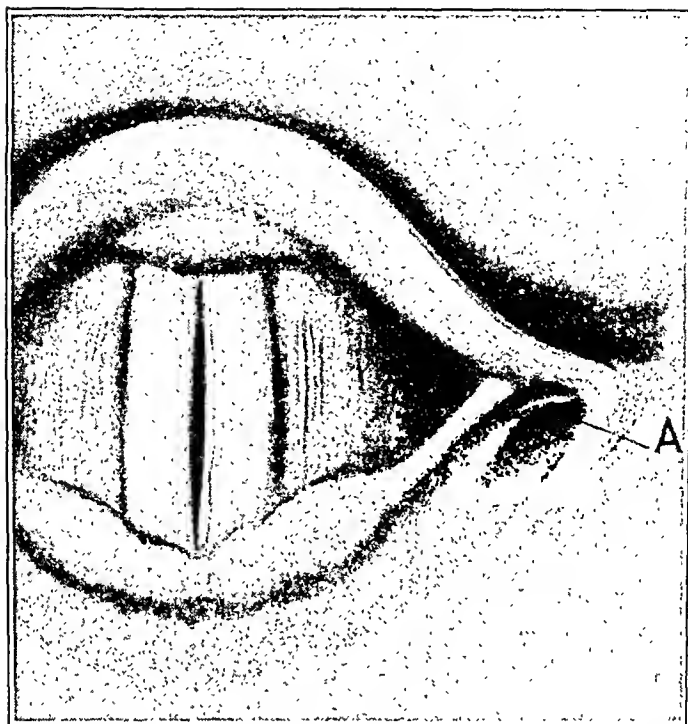


Fig. 3.—Left piriform sinus with only a part of the superior laryngeal nerve visible (*A*).

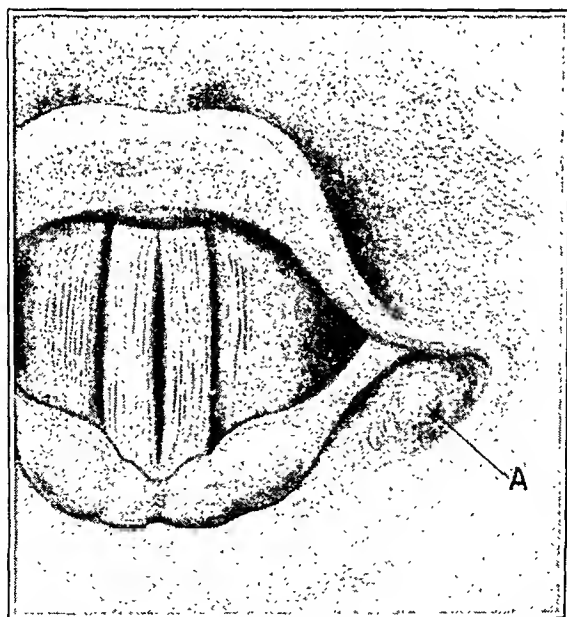


Fig. 4.—Projection of the upper cornu (*A*) of the thyroid cartilage into the piriform sinus.

the lumen of the hypopharynx and is seen a little above the piriform sinus. Similarly, fractures of the large cornu of the thyroid cartilage can be seen in the piriform sinus if the cornu is bent inward.

The course of the sensory laryngeal nerve through the piriform sinus is so superficial that it is possible to produce anesthesia of the nerve by applying a local anesthetic directly to the mucosa of the piriform sinus, provided that it is applied for a sufficient length of time. This procedure is used by some laryngologists before operations on the larynx.

In some cases of painful deglutition due to tuberculosis in which Hoffmann's method<sup>1</sup> of blocking the nerve by means of an alcohol

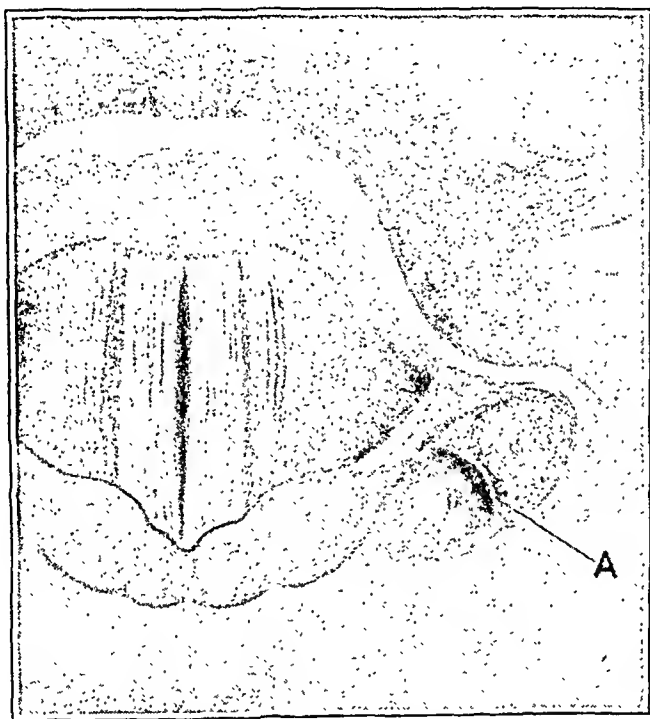


Fig. 5.—A, a fold in the left piriform sinus.

injection from the outside was unsuccessful I have succeeded in striking the nerve through the piriform sinus.<sup>2</sup>

The nerve runs below the pharyngoepiglottic fold in its course through the piriform sinus (figs. 1 and 3). The site of injection should therefore be in this area. As already mentioned, the nerve can be seen as clearly as shown in figure 1 in only the occasional larynx. It is not, however, necessary to see the nerve in order to block it by injection. A knowledge of its position in the piriform sinus is sufficient, and the

1. Hoffmann, R.: Daueranaesthesie im tuberkulösen Kehlkopf, München. med. Wchnschr. 22:739-740, 1908.

2. Schugt, H. P.: Superior Laryngeal Nerve Block Anaesthesia Via the Piriform Sinus in Tuberculosis of the Larynx, Am. J. Surg. 7:659-661, 1929.

injection need be made only superficially. I have used the Alexander syringe with a curved cannula and a fine point. Not more than 0.5 cc. of alcohol should be injected. The patient generally experiences a pain in the ear which is similar to the typical pain felt when Hoffmann's method of injecting from the outside is used. The danger of necrosis of the mucosa developing may be argued as a point against the method, but I have not as yet observed such a complication. This method should not and cannot supplant that of Hoffmann but may be used in cases in which his and other methods have failed.

The Hoffmann method is used for operative purposes when the sensory nerve is to be blocked through infiltration with procaine hydrochloride or a similar local anesthetic. I have been able to produce as satisfactory anesthesia in a series of cases by injecting procaine hydrochloride around the nerve in the piriform sinus. The approach from the outside is, however, less disturbing to the patient and easier for the physician.

The mucosa of the piriform sinus is made up of the same stratified squamous epithelium as is found in the rest of the pharynx and also contains a number of mucous glands which are subject to variation. While in one case it may be difficult to find even one mucous gland, in another there may be several. They are most often found in the greatest number on the outer surface of the arytenoid cartilages. They are rarely found on the inner surface of the thyroid cartilage (Dobrowolski<sup>3</sup>). The mucous glands of the piriform sinus rarely show cystic degeneration, a condition which is more often seen on the arytenoid cartilages and on the aryepiglottic fold. Congenital cysts the lining of which can be seen in the piriform sinus and which are really subepithelial cysts, as they do not arise from the mucous membrane of the piriform sinus although covered by this membrane, are rare. Their removal is best accomplished from the outside according to Klose<sup>4</sup>: A transverse incision between the hyoid bone and the thyroid cartilage is made from the outside. The upper border of the thyroid cartilage is then exposed, and the thyrohyoid membrane is cut. The upper border of the thyroid cartilage is freed by blunt dissection, and the cyst is removed without entering the lumen of the larynx.

It is obvious that the piriform sinus is subjected to constant irritation by food sliding past during deglutition. Whether or not this irritation plays a part in the relative frequency of carcinoma in the sinus has never

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3. Dobrowolski, Z.: Lymphatic Follicles of the Mucous Membrane of the Esophagus, Stomach, Larynx, Trachea and Vagina in Man and Animals, Pam. Towarze. Lek. Warsaw 88:458 and 801, 1892.

4. Klose, W.: Zwei Fälle von seltneren Kehlkopftumoren, Arch. f. Ohren-, Nasen- u. Kehlkopf. 145:154-158, 1938.

been proved. The act of swallowing in its relation to the piriform sinus can be studied roentgenologically with the use of barium. The latter flows to the esophageal orifice on both sides of the epiglottis. The divided stream flows along the sides of both piriform sinuses and can be seen to unite once more into one shadow at the orifice of the esophagus (von Pannewitz<sup>5</sup>).

Acute inflammations localized in the piriform sinus are rare. In such cases the patients complain of rather severe pain on the affected side. On examination the rest of the pharynx, of the nasopharynx and even of the larynx appears normal.

I have been unable to find much in the literature about the diseases of the piriform sinus. Dobrowolski<sup>3</sup> is the only who has gone into much detail about its histologic structure. He has shown that in addition to the mucous glands previously mentioned there is lymphatic tissue the structure of which closely resembles that of the palatine tonsil. He has therefore called it the tonsil of the piriform sinus. Of 60 cases he found this "tonsil" in 8. It can be found in cadavers as well as in the living subject, and it appears as a mass of tissue projecting beyond the mucous membrane. It varies in size from that of the head of a pin to that of a pea. But the greater part of this lymphatic tissue lies buried in the depths of the mucous membrane, so that it actually can be the size of a small bean. Figure 6 shows an unusually large mass of lymphoid tissue in the piriform sinus, seen in an otherwise normal patient. The "tonsil" is situated deeply in the recessus piriformis, near its anterior recess, and is sometimes barely visible.

Wiethe<sup>6</sup> and, among others, Schumacher<sup>7</sup> have confirmed Dobrowolski's findings.<sup>3</sup>

The lymphatic tissue contains a large number of follicles with germinating centers, as well as a large centrally located crypt. It is covered on its upper surface with pharyngeal mucous membrane, namely, stratified squamous epithelium. This epithelium also lines the crypt. The "tonsil" shows well developed interstitial connective tissue as well as a rather firm capsule. Wiethe has described pathologic changes in this lymphatic tissue of the piriform sinus. The histologic sections showed typical angina just as is found in the examination of the palatine tonsil. As a result of his examinations, Wiethe was able to prove that inflam-

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5. von Pannewitz, G.: Partielle Schlucklähmung als Roentgensymptom, *Fortschr. a. d. Geb. d. Röntgenstrahlen* **44**:170-177, 1931.

6. Wiethe, C.: Ueber die Tonsilla sinus piriformis: Ein Beitrag zur Aetiologie des akuten Larynxödems, *Ztschr. f. Hals-, Nasen- u. Ohrenh.* **30**:235-239, 1931.

7. Schumacher, S., in Denker, A., and Kahler, O.: *Handbuch der Hals-Nasen-Ohren-Heilkunde*, Berlin, Julius Springer, 1925, vol. 1.

matory reactions with peritonsillar edema can occur in the tonsil of the piriform sinus. It is easily understandable that this can lead to more severe complications. Edemas of the arytenoid cartilage or of the aryepiglottic fold are often seen, which in some cases cannot be attributed to primary inflammations of the tissues in the neighborhood or to an injury from a foreign body. One can understand in view of the foregoing observations that these edemas may develop from diseased lymphatic tissue in the piriform sinus.

Wiethe demonstrated with histologic sections that the cellular infiltration which occurs in the capsule of this lymphatic tissue and in the vicinity thereof is similar to that in the palatine tonsil, and that, in his

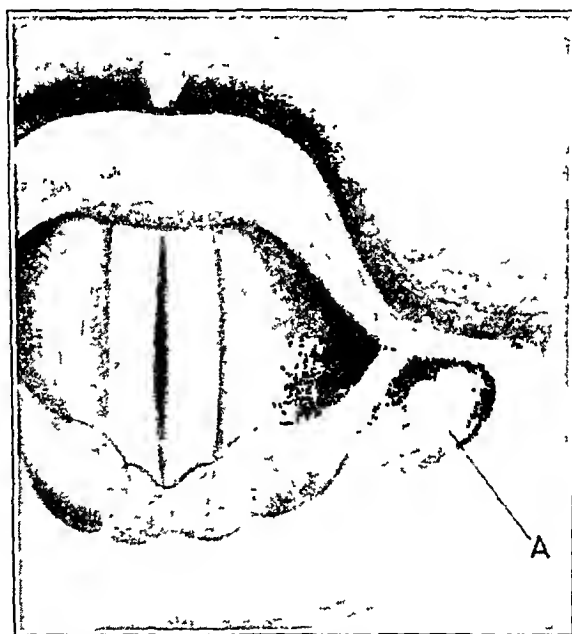


Fig. 6.—An unusually large mass of lymphoid tissue in the left piriform sinus (personal observation).

opinion, can occasionally cause a phlegmonous process of the larynx. I have often wondered how certain isolated abscesses within the larynx arise, especially those that are found on the inner side of the ala of the thyroid cartilage and extend into the piriform sinus. With the majority of these abscesses, one knows from the history and physical findings that primary tonsillitis or pharyngitis is the probable cause. For others there is a traumatic basis (Kernan and Schugt<sup>8</sup>). Occasionally, there is no evidence of any disease in the vicinity of the larynx. Since the piriform sinus forms a part of the posterior surface of the thyroid

8. Kernan, J. D., and Schugt, H. P.: Abscess of the Larynx and Its Treatment, *Ann. Otol., Rhin. & Laryng.* 43:1009, 1934.

cartilage, it is possible for an abscess to form in the larynx from an isolated infection of the lymph tissue in the sinus if the inflammation has penetrated the interior of the larynx by way of the loose sub-mucous tissue. In addition, the piriform sinus is the most dependent part of the hypopharynx and acts in a way as a receptacle for inflammations which may spread from the higher-lying organs, such as the pharynx and the tonsils. Such inflammations can easily lead to edematous conditions in the piriform sinus. This can be better understood from a study of the distribution of the lymphatics. The lymphatic structure of the piriform sinus will be described in greater detail in the course of this article.

The piriform sinus plays an important part in the diagnosis of abscess of the thyroid cartilage, but unfortunately little attention has

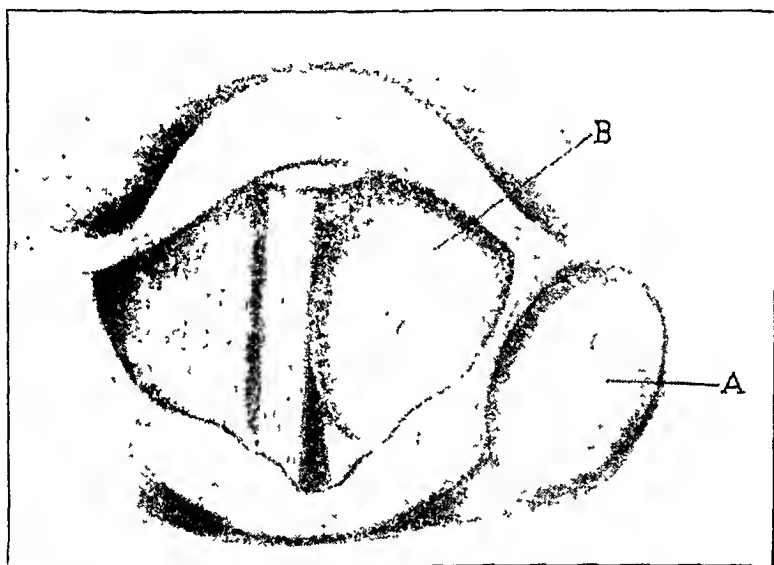


Fig. 7.—Abscess of the larynx pointing into the piriform sinus (*A*) and ventricular band (*B*).

been given in the medical literature to its importance. Pieniazek<sup>9</sup> was the first to mention the role of the piriform sinus in laryngeal abscesses. With infections of the thyroid lamina, the floor of the piriform sinus bulges upward (fig. 7), because the upper and posterior portions of the thyroid cartilage form an unyielding wall externally (fig. 8). Incisions of such abscesses through the piriform sinus are not always completely curative. The abscess cavity refills with pus, and after a few days a fluctuating mass can again be found in the piriform sinus. In the paper previously mentioned,<sup>8</sup> Kernan and I described a method of approaching such abscesses from the outside through an opening in the thyroid cartilage (fig. 9). This permits better drainage. In 1 case I incised the

9. Pieniazek, P.: *Die Verengerungen der Luftwege*, Vienna, Franz Deuticke, 1901, p. 140.

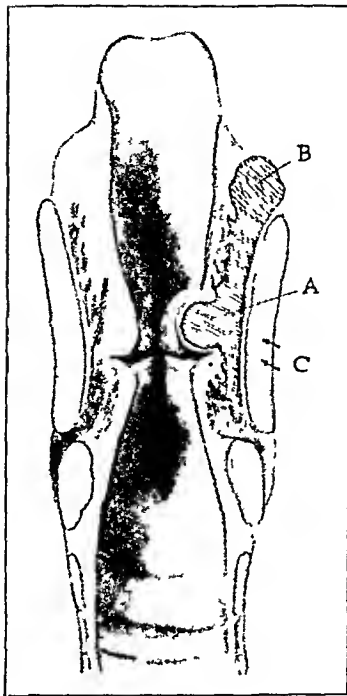


Fig. 8.—Section through the larynx to show the extension of an abscess, as seen in figure 7. *A* indicates the abscess pushing into the lumen of the larynx and *B* the abscess bulging into the piriform fossa. At *C* the arrows show the site of the window made through the cartilage in order to approach the abscess.

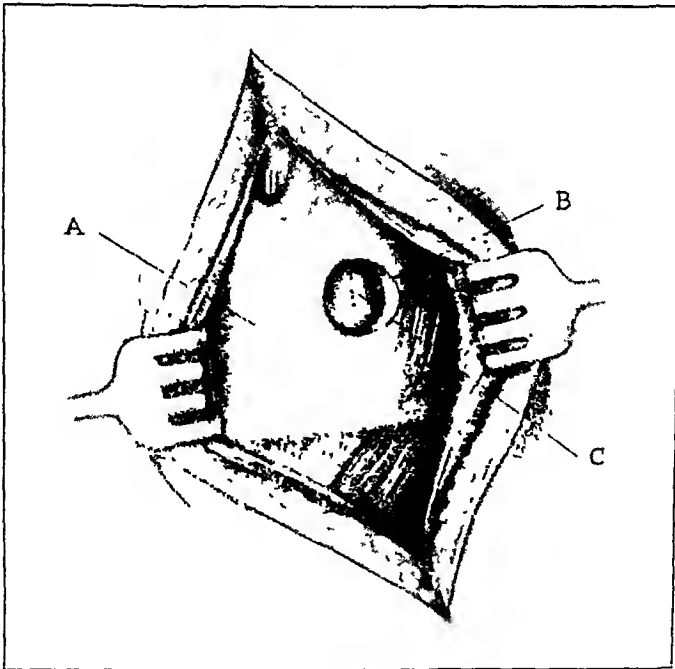


Fig. 9.—External approach to the abscess in the larynx and piriform fossa through (*A*) exposure of the thyroid cartilage and (*B*) a window in the thyroid cartilage. *C* indicates the inner perichondrium, incised. The abscess was found to be between the mucosa and the perichondrium.

abscess through the piriform sinus several times before deciding to approach it externally through an opening in the thyroid cartilage. There were no ill effects from the repeated internal incisions. However, 1 of the cases illustrates that the incising of a laryngeal abscess from above, as is recommended in the textbooks, should be done with caution, especially if there is great swelling and distortion of the parts. The patient had considerable swelling in the region of the aryepiglottic fold and near the piriform sinus. He was in great distress and had difficulty in breathing. The larynx was exposed with a direct laryngoscope, and an incision was made into the most prominent part of the swelling. Pus was released, but there was also a profuse hemorrhage, which might

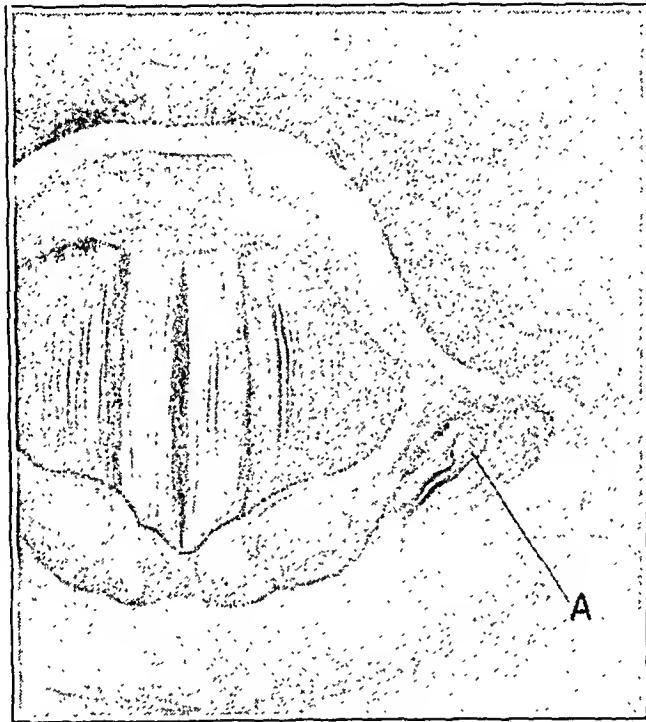


Fig. 10.—Left piriform sinus with dilatation of the superior laryngeal vein (A).

have been fatal and which subsequently required exposure and ligation of the carotid artery. Figure 10 shows the piriform sinus with a dilated vein, the superior laryngeal vein. It is not hard to understand that a hemorrhage from this vessel or from the nearby artery can occur when a laryngeal abscess is incised.

The anatomy of this region explains why inflammations in the piriform sinus do not always remain localized. Posteriorly and laterally the piriform sinus is in contact with the posterior surface of the pharynx. This in turn is bound to the prevertebral fascia by loose, movable connective tissue, rich in lymphatics. Thus there is a direct path for inflammation to spread to the mediastinum. At this point the various ways should be described in which abscesses of the posterior surface of the



thyroid cartilage, particularly those of the piriform sinus, can invade the neighboring tissues of the neck and the mediastinum:

1. Pus can spread from the piriform sinus along the posterior surface of the thyroid cartilage and, breaking through the cricothyroid ligament, reach laterally into the deep tissues of the neck. From here the pus can then follow the great vessels into the mediastinum. Kernan and I have described a case.<sup>8</sup> The remarkable thing about this case was that the abscess crossed over between the trachea and the esophagus to the opposite side and in this way reached the mediastinum on that side (fig. 11).

2. Another path exists from the piriform sinus around the posterior edges of the thyroid cartilage into the region of the great vessels (fig. 12). We described such a case, in which the abscess was drained externally through an incision.<sup>8</sup> The pus was found on the outer covering of the inferior constrictor muscle of the pharynx. Laryngeal examination in this case revealed a large mass involving the right aryepiglottic fold and piriform fossa. This mass was displaced toward the left side by a swelling of the right lateral pharyngeal wall. The appearance of the larynx, together with the presence of an external swelling, was evidence that the pus had made its way from the piriform fossa to the outside of the larynx and from there to the sheaths of the great vessels.

3. The abscess in the piriform sinus can break through the thyroid cartilage anteriorly without being definitely palpable or visible. This is due to its deep position behind the sternohyoid and sternothyroid muscles. In such cases the abscess may burrow downward and be imperceptible until later, after it has descended into the mediastinum. It may then appear as a painful swelling in the second intercostal space next to the sternum. O. Mayer, of Vienna,<sup>10</sup> described such a case. I, myself, have never seen this rare complication. In most instances, when the abscess has broken through the thyroid cartilage anteriorly, it can fortunately be palpated on the outer surface of this cartilage and thus be readily diagnosed. Figure 13 shows the swelling in such a case, and figure 14 shows the findings after exposure of the thyroid cartilage. In this case necrosis of the upper part of the cartilage was present. A probe could be passed from there into the piriform sinus and could be seen there on examination with the mirror.

4. The fourth path has already been mentioned and leads from the piriform sinus into the neighboring spatium praevertebrale, from which

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10. Mayer, O.: Beiträge zur Behandlung der Perichondritis laryngea auf Grund eigener klinischer und histologischer Untersuchungen, Ztschr. f. Hals-, Nasen- u. Ohrenh. 28:309-379, 1931.

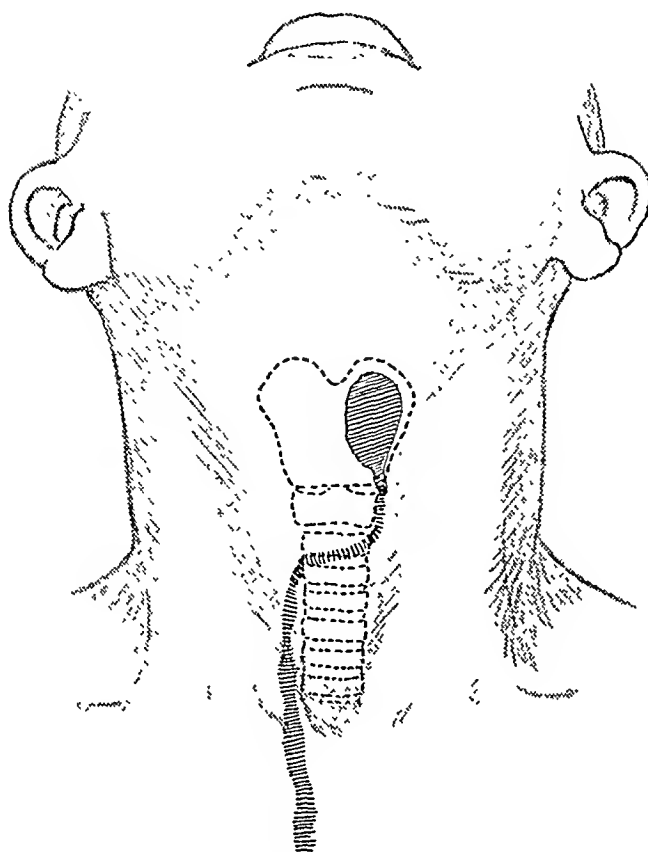


Fig. 11.—An abscess in the larynx behind the left thyroid plate and in the piriform fossa has broken through the cricothyroid membrane and burrowed downward behind the trachea into the right side of the mediastinum.

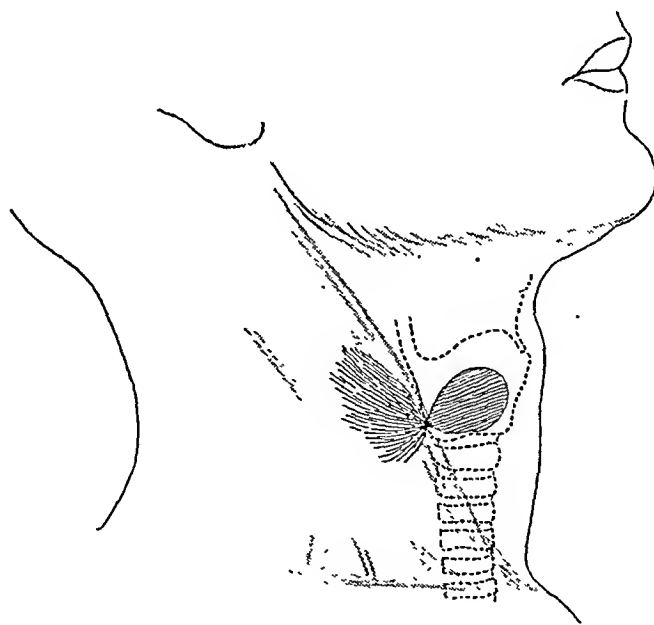


Fig. 12.—An abscess of the larynx after breaking through the piriform sinus into the paralaryngeal space, pushing the sternocleidomastoid muscle laterally.

a direct path leads to the posterior mediastinum. Roberts<sup>11</sup> asserted that in cases in which an abscess of the piriform sinus ruptures downward into the posterior mediastinum, the mediastinum can be opened and

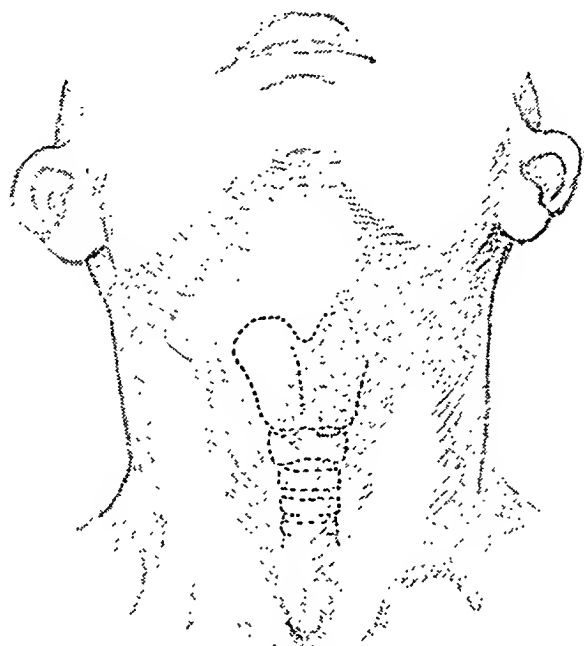


Fig. 13.—External swelling, after the abscess has broken through the thyroid cartilage to the outside.

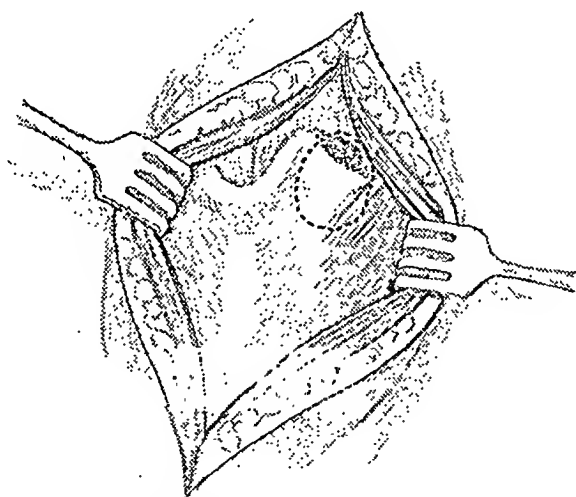


Fig. 14.—Thyroid cartilage exposed. The dotted line indicates the size of an abscess found behind a necrotic area. The probe leads into the piriform sinus.

drained through the piriform sinus. He has described a case in which this treatment was successful. The distance from the piriform sinus to the

11. Roberts, S. E.: A New Surgical Approach to the Mediastinum Through the Piriform Sinus, *Ann. Otol., Rhin. & Laryng.* 44:493, 1935.

dome of the posterior mediastinum is 6 to 7 cm. In his case of mediastinitis in a child, in which there was "pointing" in the piriform fossa, an incision 3.5 cm. deep was made in the fossa. Sixty cubic centimeters of pus was released. Roberts made investigations on dogs concerning the accessibility to the mediastinum through the piriform sinus. Iodized poppyseed oil injected into the piriform sinus of a dog was seen well down in the posterior mediastinum three hours later and followed the normal cervical curve. He was able to demonstrate that the prevertebral cervical fascial planes can easily be separated when approached from above through the piriform fossa. He stated the belief that a surgical approach to the mediastinum through the piriform sinus is entirely practical from both a clinical and an anatomic point of view. Voss<sup>12</sup> opened the mediastinal space in 4 cases of posterior mediastinitis through an incision of the posterior pharyngeal wall and by tearing through the strands of connective tissue with the finger in the retropharyngeal space succeeded in establishing good drainage of the mediastinum. This procedure approximately corresponds with Robert's experimental work on dogs, even though Voss did not limit himself strictly to the piriform sinus. It should therefore be kept in mind that in cases of mediastinitis in which an external operative procedure has not been satisfactory, an internal exposure, as described by Voss, may be successful.

The piriform sinus is of further interest as a channel for the lymphatics of the hypopharynx, the upper part of the larynx and part of the base of the tongue. The lymph vessels run beneath the mucous membrane of the piriform sinus and pass through the thyrohyoid membrane alongside the superior laryngeal artery to reach the deep cervical glands.<sup>13</sup> On their way to these, in some cases, they pass through a row of small lymph nodules which lies next to the thyrohyoid membrane (fig. 15). These lymph glands are not always present. When they are, they lie either in front of or somewhat below the hyoid bone or at times beneath the muscles radiating away from the hyoid bone. Most<sup>14</sup> and Poirier<sup>15</sup> described the presence of such glands at the upper border of the thyroid cartilage or, to be still more exact, at the lateral margin of the thyrohyoid muscle. In discussing the tumors of the piriform sinus,

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12. Voss, O.: Ein einfaches aber anscheinend unbekanntes Hilfsmittel zur Eröffnung gewisser Fälle von Mediastinitis posterior, *Acta oto-laryng.* **26**:292-304, 1938.

13. Sappey, M. P. C.: *Anatomie, physiologie, pathologie des vaisseaux lymphatiques considérés chez l'homme et les vertébrés*, Paris, A. Delahaye & E. Lecrosnier, 1874.

14. Most, A.: *Topographie des Lymphgefäßapparates des Kopfes und Halses, in ihrer Bedeutung für die Chirurgie*, Berlin, A. Hirschwald, 1906.

15. Poirier, P.: *Lymphatiques*, Paris, Masson & Cie, 1902; *Vaisseaux lymphatiques du larynx; vaisseaux lymphatiques de la portion sous-glottique; ganglion pré-laryngé*, *Progrès méd.* (pt. 2) **5**:373, 1887.

Mikulicz and Kuemmell pointed out that "such an enlargement of the glands in the space between the thyroid cartilage and the hyoid bone must be considered as very suspicious when it occurs in older people."

I have mentioned that the piriform sinus acts as a gathering place for the lymphatics of the lower part of the pharynx and the larynx and that, as a result of this, congestive symptoms can easily be present there when the higher-lying parts, such as the hypopharynx, the base of the tongue and the larynx, are infected. With infections of the pharynx, there may be not only a swelling but real edema in the piriform sinus, and this can spread from there to the epiglottis and the remaining portions of the larynx.



Fig. 15.—Lymphatic system of the larynx, showing the piriform sinus (A) with lymphatics passing through the thyrohyoid membrane. B indicates lymph nodules near the thyrohyoid membrane (C). (From Sappey.<sup>13</sup>)

At this point I should like to call attention to patients who complain of more or less severe pain on swallowing, at times long after they have recovered from infections of the throat. On examination there is definite tenderness to pressure on the lateral border of the thyroid cartilage or of the hyoid bone or to pressure over the space between them, namely the thyrohyoid membrane. Most of these patients state that the pain is not present when eating but only when they go through the motions of swallowing. Examination of the throat and larynx usually shows slight redness of the hypopharynx or of the lingual surface of the epiglottis. At times the lingual tonsil or the piriform sinus may be

swollen. The pain on swallowing and the tenderness to pressure over the area just described are often accompanied by the sensation of a foreign body being present in the throat. The explanation of these symptoms in many cases is a painful irritation of the tissues near the place where the lymphatics coming from the piriform sinus pierce the thyrohyoid membrane. In addition to this, the superior laryngeal nerve is situated close to the thyrohyoid membrane and may also easily be involved. This would cause the pain to be more severe.

Since the piriform sinus adjoins the posterior surface of the thyroid cartilage and extends to the thyrohyoid membrane anteriorly, it is easy to see that inflammations in this sinus can occasionally cause secondary infections of the upper and outer part of the throat. Von Eicken<sup>16</sup> described a case of this sort in which as the result of an injury to the anterior part of the piriform sinus, caused by the removal of a foreign body, an infection developed in the uppermost part of the upper pole of the thyroid gland. The infection went on to the formation of an abscess, which pointed externally.

It is well known that foreign bodies are easily impacted in the piriform sinus. Pointed foreign bodies, such as needles and fish bones, may be buried beneath the soft mucous membrane through the act of swallowing and at times are therefore invisible on examination. Boskowitz described a case in which a sewing needle could be shown in the piriform sinus only roentgenographically. He subsequently removed it through an incision in the sinus.

In 1904, Von Eicken<sup>17</sup> was the first to describe an unusual finding in cases of esophageal diverticulum, namely, frothing in the piriform sinus. In America, Chevalier Jackson greatly stressed this finding in diseases of the esophagus, and it is called the "Jackson sign." Other authors (Oppikofer,<sup>18</sup> Györgyi,<sup>19</sup> Freystadt,<sup>20</sup> Wagener<sup>21</sup>) have noticed this frothing in the following diseases, in all of which there is more or less disturbance in swallowing: aortic aneurysm, substernal thyroid,

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16. Von Eicken, C.: Schilddrüsenabszess nach Verletzung des Sinus pyriformis, *Ztschr. f. Hals-, Nasen- u. Ohrenh.* **21**:156-161, 1928.

17. Von Eicken, C.: Die klinische Verwertung der direkten Untersuchungsmethoden der Luftwege, *Arch. f. Laryng. u. Rhin.* **15**:372-494, 1904.

18. Oppikofer, E.: Die diagnostische Bedeutung der Schaumbildung in den Sinus piriformes bei Speiseröhrendivertikel, *Cor.-Bl. f. schweiz. Aerzte* **47**:1133, 1917.

19. Györgyi, G.: Die diagnostische Bedeutung der Pharynxtaschenfüllung, *Fortschr. a. d. Geb. d. Röntgenstrahlen* **46**:422-427, 1932.

20. Freystadt, B.: Kehlkopf und Rachen in ihren Beziehungen zu den Erkrankungen des Zentralnervensystems, Berlin, S. Karger, 1928.

21. Wagener, O.: Zur Diagnose der Schlucklähmungen, *Beitr. z. prakt. u. theoret. Hals-, Nasen- u. Ohrenh.* **10**:230-234, 1918.

tumor of the esophagus, esophageal varices and bulbar paralysis. I myself have often seen definite frothing with diseases of the esophagus, with bulbar paralysis and with substernal thyroid. In some cases of progressive bulbar paralysis, the presence of frothy saliva in the piriform sinus is the first indication that swallowing is impaired. The patients themselves do not complain of difficulty in swallowing in the early stages of this disease, and it is only on questioning that they realize that there has been some disturbance, as evidenced by a sensation of the food sticking in the throat, which necessitated the drinking of fluids to wash it down. The extent of the disability to swallow can be estimated objectively when the symptom of frothing in the piriform sinus is observed. This can be best demonstrated by having the patient drink milk. When swallowing is normal, the piriform sinus is completely empty after a few minutes. When swallowing is disturbed, the blue-white color of the milk is still visible even after a prolonged interval. In healthy persons, frothing in the piriform sinus is never marked, if it is at all present, and it varies from time to time in the individual.

In my experience this sign is a valuable early indication that there is a disturbance in swallowing. In a number of patients, my attention was called by this sign to the impairment of swallowing even before the patients themselves were at all aware of such disturbances. Some authors<sup>22</sup> have attempted to explain the mechanism of frothing in the piriform sinus, but, as there has been no unanimity of opinion among them, I should not like to discuss it further.

At this point I should like to touch briefly on the methods of examining the piriform sinus. In general, examination with the mirror suffices. When there is any doubt, however, as to pathologic changes, especially when malignancy is suspected, a direct examination should be made. Pathologic changes are most easily overlooked on the medial surface beneath the arytenoids, in other words, in the deepest part of the piriform sinus. The reason for this is that the arytenoid cartilage and the aryepiglottic fold often form a deep, sharp angle with the piriform sinus, and one cannot always see into this angle with the mirror alone. In such cases the arytenoid cartilage and the aryepiglottic fold must be pushed aside medially. This is best accomplished by means of the direct laryngoscope of Jackson. One is often amazed how extensive some changes, especially those due to tumors, may appear, which on examination with the mirror were at first not too obvious. The early recognition of malignant diseases depends to a large extent on a thorough examination of the piriform sinus.

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22. Gerlings, P. G., and den Hoed, D.: The Significance of the Stagnation of Secretion in the Valleculae Glossoepiglotticae and in the Sinus Pyriformes, *Acta oto-laryng.* 22:519-528, 1935.

At the Paris Cancer Institute it has been found that 60 per cent of the tumors of the hypopharynx originate in the piriform sinus. Some are radiosensitive and show but little tendency to extension, whereas others are malignant. Most of the cancers of the piriform sinus are particularly dangerous because of their glandular metastases. The patients usually come for treatment only when difficulty in swallowing has developed, a symptom which indicates an extension to the pharyngeal wall. One should be suspicious of a beginning cancer of the piriform sinus in patients of advanced age with complaints of tickling in the throat and a frequent desire to clear it.

I have already mentioned that the majority of the lymphatics of the larynx, especially of its upper part, pass through the piriform sinus. This fact seems to me of importance in considering the metastases of malignant tumors of the larynx, particularly in cases in which a decision must be reached whether a growth is intrinsic or has already spread and must be considered extrinsic. Until now one has been guided by whether the cervical glands were palpably involved, whether some other change in the larynx could be seen or, finally, whether a softening or hardening of the laryngeal skeleton could be felt on palpation. Jackson has stressed that it is most important to palpate the outer surface of the thyroid and cricoid cartilages thoroughly in search for such changes and that the presence of a prelaryngeal gland on the cricothyroid ligament must be sought, a gland which is frequently overlooked. I believe one can add another examination to these, namely, a thorough examination of the piriform sinus.

It is important at this point to discuss once again the lymphatics of the larynx, especially those of its upper portion. The lymph drains off through four or five vessels that pierce the wall of the larynx beneath the aryepiglottic fold and then run past the arytenoid cartilage (fig. 15). All these lymph vessels continue beneath the mucous membrane of the piriform sinus and along the superior laryngeal artery through the thyrohyoid membrane to the outside. There, in many cases, they pass through one or more small lymph nodules which are a part of the chain of deep cervical glands and which were described earlier in this paper.

It must be assumed that the malignant cells reach the cervical glands through the lymphatic system of the piriform sinus. One must further assume that the lymphatic system of the piriform sinus is already involved with carcinoma in many cases, even before such involvement is apparent on superficial examination and before it can be demonstrated in the cervical glands. It is therefore of great importance to determine whether an intrinsic tumor of the larynx has already implanted itself in the piriform sinus. In this respect the following changes in the piriform sinus should be considered and looked for. The larynx may deviate



toward the uninvolved side when the submucous tissue in the piriform sinus is already infiltrated, even though the infiltration is minimal. It is therefore important to examine the position of the larynx in relation to the lateral pharyngeal wall. This is measured mainly by the distance between the aryepiglottic fold and the lateral pharyngeal wall on each side. In a similar way the depths of both piriform sinuses can be compared. Because of the infiltration of the piriform sinus, its floor may be raised and it may appear more shallow. Such changes are sometimes slight and cannot be seen on examination with the mirror. For this reason I have already recommended examining the piriform sinus by the direct method or even palpating it with the finger. With the area under carefully induced local anesthesia, the index finger can be inserted into the larynx and the tissues of the piriform sinuses comparatively palpated for changes and thickenings. In the same way, the thyrohyoid membrane can be palpated through the piriform sinus for possible infiltrations, and the presence or absence of small carcinomatous glands on or to the side of the thyrohyoid membrane can be determined, if the membrane is palpated from the inside through the piriform sinus and at the same time from the outside with the other hand. To summarize briefly, the following findings in an examination of the piriform sinus for possible malignant infiltrations should be considered:

1. Deviation of the larynx to one side.
2. Enlargement of the diseased piriform sinus.
3. Shallowness of the piriform sinus through bulging of its floor.
4. Hardening of the thyrohyoid membrane.
5. The presence of small glands on and to the side of the thyrohyoid membrane.

# CHONDROMA OF THE ETHMOID

WITH REPORT OF A CASE

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Chondroma of the ethmoid attracts the attention of clinician and pathologist alike—the former because of its bizarre course and symptoms; the latter because of its comparative rarity. Chondroma is rare in any region of the body but is found least frequently in the nose and accessory sinuses. The minimal incidence of such neoplasms is attested by Geschickter<sup>1</sup> in a classification of 211 tumors of the nasal and paranasal cavities, selected from over 2,000 specimens removed surgically at the Johns Hopkins Hospital. In this series there were 19 benign epithelial tumors, 139 malignant epithelial tumors, 37 benign tumors of connective tissue (exclusive of 76 osteomas) and 16 sarcomas. The benign tumors of connective tissue consisted of angioma, plasmocytoma and fibroma; no case of chondroma was found.

Enchondroma, a cartilaginous tumor within a cavity, was first described by Müller,<sup>2</sup> in 1836. Virchow<sup>3</sup> in 1857 created the term myxoma and divided soft enchondromas into myxomatous enchondroma, in which cartilage predominates, and cartilaginous myxoma, in which mucous tissue is more abundant. In 1868 Trerneuil<sup>4</sup> reported a case of myxomatous enchondroma arising from the ethmoid of a boy aged 11 years. In McAuliffe's<sup>5</sup> case myxochondroma in the nose of a child 8 months old did not appear to involve the ethmoid except by possible secondary invasion, as it arose from the inferior turbinate and extended upward to involve the lateral nasal wall and the anterior wall of the maxillary sinus. Observations on 29 cases collected by Sicard<sup>6</sup> in 1897

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1. Geschickter, C. F.: Tumors of the Nasal and Paranasal Cavities, *Am. J. Cancer* **24**:637 (July) 1935.

2. Müller, J.: Rede zur Feier des zwei und vierzigsten Stiftungstages des königlichen, medicinisch-chirurgischen Friedrich-Wilhelms-Instituts, Berlin, Gebrüder Unger, Aug. 2, 1836.

3. Virchow, R.: Ein Fall von bösartigen, zum Theil in der Form des Neuroms auftretenden Fettgeschwülsten, *Virchows Arch. f. path. Anat.* **11**:281, 1857.

4. Trerneuil, cited by Uffenorde.<sup>7</sup>

5. McAuliffe, G. W.: Myxochondroma in the Nose of a Child Eight Months Old, *Laryngoscope* **48**:206 (March) 1938.

6. Sicard, J.: Des tumeurs cartilagineuses (enchondromes) des fosses nasales, Paris, J. B. Baillière & fils, 1897.

are not strictly applicable to the subject of this discussion, as the majority of the growths were enchondroma of the septum or a mixed tumor of extranasal origin.

Uffenorde<sup>7</sup> in 1908 recorded the removal by "paranasal rhinotomy" of a chondroma arising from the ethmoid of a woman aged 21. During three months proptosis, diplopia, nasal obstruction and unilateral headache had developed, and the mass could be seen by posterior rhinoscopy as well as under the middle turbinate anteriorly. The histologic diagnosis was chondroma with myxomatous degeneration. Supplementing the case report Uffenorde stated that chondroma is a rare tumor in the nose, liable to malignant degeneration; it makes its appearance before the age of 25, affects the two sexes equally and grows most often from the ethmoid.

Paradzik<sup>8</sup> reviewed the report by Schlittler of 51 collected instances of nasal chondroma and reported 1 of his own, as well as a septal chondroma described by Cemach and 2 enchondromas of the ethmoid, described by Fraser and by Klaue.<sup>9</sup> His own case was that of a large firm chondroma in a man 45 years of age; the duration of only six months was considered unusual. Arising from a rather broad base, the tumor took in the entire ethmoid area, filled the antrum and canine fossa and deflected the nasal septum toward the opposite side; the sphenoid sinus and the orbit were not involved. The patient had been free of recurrence for six months when last seen.

Howarth<sup>10</sup> contributed to the knowledge of the subject, although his particular case was one of septal involvement. He stated: "The . . . case would seem to be worthy of record since chondroma is one of the rarest of intranasal tumors and the recorded cases are singularly few in number." He referred to the work of Heymann,<sup>11</sup> and considered the tumors best explained as arising from "cartilaginous rests" that may occur when the area is undergoing ossification.

Hopmann<sup>12</sup> described a case of enchondroma arising from the ethmoid, encroaching on the septum and filling the sphenoid; the pos-

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7. Uffenorde, W.: Die Chondrome der Nasenhöhle und Mitteilung eines Falles von Enchondrom des Siebbeins, Arch. f. Laryng. u. Rhin. **20**:255, 1908; abstracted, J. Laryng., Rhin. & Otol. **23**:269 (May) 1908.

8. Paradzik: Ueber ein Chondrom des Siebbeins, Ztschr. f. Hals-, Nasen- u. Ohrenh. **22**:505, 1929.

9. Klaue, H.: Ein Chondrom des rechten Siebbeines, Ztschr. f. Laryng., Rhin., Otol. **13**:121, 1924-1925.

10. Howarth, W.: Chondroma of the Nasal Septum, J. Laryng., Rhin. & Otol. **45**:191 (March) 1930.

11. Heymann, P.: Handbuch der Laryngologie und Rhinologie, Vienna, A. Hölder, 1900, vol. 3, p. 851.

12. Hopmann, E.: Enchondrom des Keilbeins, der Siebbeine und der Nasenscheidewand, Ztschr. f. Laryng., Rhin., Otol. **21**:454 (Aug.) 1931.

terior wall of the latter was destroyed. The symptoms were headache, partial anosmia, visual disturbances and proptosis of the right eye. Surgical removal of the tumor gave a good cosmetic result and uneventful recovery.

Lugli<sup>13</sup> in 1931 published a monograph containing a review of the literature to date and the report of a case of ethmoid chondroma in a girl aged 11 years. He also discussed the incidence, origin and extension of the neoplasm, the symptoms, the diagnosis and the differential diagnosis, especially from osteoma, mucocoele and suppurative ethmoiditis with orbital perforation. The gross and microscopic pathologic picture, as well as the surgical treatment, were covered in great detail. He emphasized that, while classed as a benign tumor histologically and biologically, chondroma of the ethmoid may appear clinically nonbenign and dangerous to the patient; growth is by compression of bony structures rather than by infiltration; the course is slow—in one case twenty-five years—and there is a marked tendency to recur. Citelli is cited as including the condition in a separate group of tumors of intermediate gravity, along with osteoma, adenoma and papilloma, rather than with frankly benign tumors.

Rubaltelli<sup>14</sup> reported the successful removal of a walnut-sized chondroma from the left ethmoid of a 16 year old carpenter. For about five months prior to admission to the clinic there had been progressive external deviation, exophthalmos and marked loss of vision of the left eye. A hard, fixed, painless mass was palpated in the superomedial angle of the orbit, and a corresponding bulging was noted intranasally. Operation, with the area under local anesthesia, was performed by the centropacial approach of Citelli; the frontal and maxillary sinuses had to be opened to remove aseptic mucocoeles which came to view while the tumor was displaced, but these cavities did not contain chondroma. An excellent cosmetic result was seen after seventeen months, and there was no recurrence.

To a comprehensive survey of the available literature, Menne and Frank<sup>15</sup> added a report of a case of slow progressive development of chondroma in a laborer aged 44; the growth was not recognized until it had invaded the left orbital cavity, and when finally presented for treatment it was inoperable, the total course having been four and one-half years. The tumor studied by roentgenographic examination and

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13. Lugli, G.: Condroma dell'etmoide, *Arch. ital. di laring.* **50**:135 (June) 1931.

14. Rubaltelli, E.: Voluminosa condroma etmoidale sinistro con mucocoele pan-sinusale e grave sindrome oculare, *Riv. oto-neuro-oftal.* **14**:48 (Jan.-Feb.) 1937.

15. Menne, F. R., and Frank, W. W.: So-Called Primary Chondroma of the Ethmoid, *Arch. Otolaryng.* **26**:170 (Aug.) 1937.

at autopsy was shown to involve, besides the orbits, the septum, palate, nasopharynx, cribriform plate and cranial cavity. The authors pointed out that the exact origin of such tumors frequently cannot be determined when they are seen in later stages of development; they suggested a plausible theory of origin in the processus sphenoidalis septi cartilaginei and questioned the ethmoid origin of true chondroma.

It is evident, then, that chondroma of the ethmoid shows a predilection for young patients, chiefly between the ages of 10 and 25 years. In my case, presented hereafter, the symptoms were first noticed by the patient at the age of 41, although the characteristic slow growth may indicate that the actual origin was years earlier. Trauma has not been shown to be a factor as with osteoma and mucocele. Development takes place in bony areas during the active growth of the person, from "cell rests." Although nonmalignant, chondroma in this region tends to recur; this clinical habit may be attributed partially to the fact that complete surgical extirpation cannot always be accomplished, the apparent recurrence being in reality proliferation of remaining tissue. Symptoms suggesting involvement of the orbit invariably predominate, nasal obstruction being secondary and occurring later in the course of the disease.

Because of the relative rarity of the condition and the complications which may intervene in its course, it seems desirable to set down the following experience with a patient in whose case the clinical picture extended over sixteen years.

#### REPORT OF CASE

Mrs. E. C., aged 56, was referred by an oculist on Nov. 30, 1936 for treatment of an orbital abscess which seemed to be related to disease of the accessory sinuses. Her past history was interesting; with the exception of a gastric operation in 1934, all her previous illnesses had been referable to the region of the head. In September 1921 she had consulted the late Dr. W. C. Bane on account of a hard mass about 1 cm. in diameter, located on the left infraorbital rim below the ocular caruncle; it was apparently connected with a similar mass attached to the upper lateral nasal wall, extending medially to contact the septum and disappearing on external pressure when the intranasal portion was removed. A pathologic section was reported as showing chondroma.

No further symptoms developed until 1927, when similar areas appeared on the lateral nasal wall and in the ethmoid region and were removed by the intranasal route. At this time the tissue removed was softer, and pathologic examination of fragments showed myxomatous tissue infiltrated by polymorphonuclear leukocytes and lymphocytes; the diagnosis was infected myxoma.

Again there was comparative freedom from symptoms for six years; in 1933, an abscess developed in the canine fossa and was incised infralabially; about a month later it was deemed advisable to perform a Caldwell-Luc operation on

the left antrum to facilitate the removal of a cartilaginous mass involving the ethmoid and the upper part of the antrum and encroaching on the nasal septum sufficiently to push it noticeably to the right. An abscess was encountered on the lateral wall of the antrum beneath the mucosa. An intranasal opening was made in the middle rather than the inferior meatus. Sections of tissue removed at this time were diagnosed pathologically as fibrochondroma. Residual masses of cartilage were removed from the lower orbital rim four months later.

The sinusal condition remained quiescent, but in 1934 purulent dacryocystitis made its appearance on the left side; this was relieved by repeated lacrimal irrigations, but it was impossible to pass a probe from the nasolacrimal duct into the nose, and lacrimation continued from that time. A probe could be passed into the antrum through the middle meatus at the site of a former antrotomy.

In August 1936 there was swelling of the left upper eyelid, which progressed to a definite orbital abscess (fig. 1); this was incised by the family physician and later by the oculist, drainage continuing intermittently for more than three

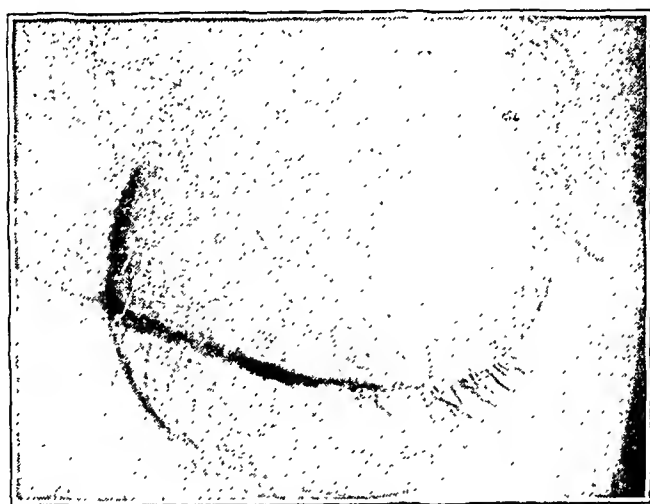


Fig. 1.—Orbital abscess, seventh day, secondary to obstruction of the frontal sinus caused by chondroma.

months from an opening below and lateral to the midportion of the brow. It was at this point in a rather lengthy train of events (Nov. 30, 1936) that the patient first presented herself to me.

Examination disclosed a woman somewhat beyond middle age, in a good state of general health, with a fistulous opening in the left upper lid, through which a probe could be passed into the floor of the left frontal sinus. The intranasal examination revealed a straight septum with no evidence of tumefaction; the right side of the nose was normal; a portion of the left middle turbinate was absent. High in the ethmoidal recess a small opening was noted, which, on being probed and dilated with frontal sinus sounds, established a communication via the nasofrontal duct with the frontal sinus; this was verified by cross probing from the fistulous opening in the brow. A large amount of gelatinous material was evacuated from the intranasal opening and good drainage established, with the result that within a few days the external wound closed.

Roentgen examination of the sinuses on December 12 was reported as follows: "Both frontal sinuses are well developed and lobulated by incomplete partitions; the right is clear; the left shows increased density in its superior medial portion and toward the outlet. The right ethmoid is clear; the left shows increased density, especially in the portion adjoining the orbit; the contour of the upper inner margin of the orbit is lost. The right antrum is clear; the left is clear except in the upper inner angle, where increased density is superimposed from the ethmoid. The sphenoid sinuses are clear."

In view of the failure of previous intranasal procedures to relieve permanently a condition which was obviously becoming more extensive, external operation was advised. However, the patient, delighted over the clinical improvement, including the cessation of the lacrimation present continuously for two and one-half years, declined operation. There followed during the next nine months a series of some four or five episodes of a few days' duration when sudden swelling appeared in the orbit, followed by spontaneous reopening of the fistulous tract and evacuation of an abscess, with partial resolution. These attacks transpired in spite of an unchanged intranasal condition, a nasofrontal duct which admitted a no. 14 (French) sound and no headache. About May 1, 1937, a definite bulge appeared in the superomedial angle of the orbit, and this area, tense in character, continued to become more prominent; on palpation the mass revealed a "celluloid-like" feeling similar to that characteristic of mucocele.

Finally, when the economic hazards incident to hospitalization and operation had been overcome, the patient was admitted to Colorado General Hospital on October 23, with a diagnosis of chronic ethmoid and frontal sinusitis on the left side, recurrent orbital abscess and tumor of the left ethmoid. On admission, the temperature was normal; the pulse rate, 80, and the blood pressure, 140 systolic and 100 diastolic; a slight systolic blowing murmur limited to the cardiac apex and a healed operative scar in the midline of the abdomen were the only abnormal physical findings aside from those referable to the ethmofrontal region. Examination of the blood showed mild secondary anemia; the urine was normal.

After preliminary medication with barbiturates followed by hypodermic injection of scopolamine and morphine, orbital block anesthesia was accomplished with a 2 per cent solution of procaine hydrochloride and epinephrine hydrochloride; this was supplemented by a 5 per cent solution of cocaine hydrochloride administered intranasally for surface anesthesia. Through a  $\frac{1}{2}$  inch (1.3 cm.) incision a modified Lynch operation was performed. There was a hard cystic swelling, 1.5 cm. in diameter, in the region of the floor of the left frontal sinus and the left ethmoid, to the nasal side and above the inner canthus; the floor of the frontal sinus and the external wall of the ethmoid were found to be necrosed by the tumor and suppuration; the frontal sinus and the ethmoid cells revealed chronic thickened membrane and contained free pus.

The operation consisted of removal of the tumor and its limiting capsule, with exenteration of all accessible ethmoid cells, removal of the floor of the frontal sinus and evisceration of the lining frontal mucosa; a large iodoform oiled gauze pack was carried from the ethmofrontal cavity into the nose; the wound was closed with fine dermal sutures. The packing was removed on the second day and the sutures taken out on the fourth day, at which time the patient left the hospital; periocular edema subsided rapidly, and healing was well established at the end

of ten days. The end result may be best determined by the photograph (fig. 2) taken six months postoperatively. It is now two years since the operation; the chondroma has not demonstrably recurred, and all sinusal suppuration has ceased.

The report of a pathologic examination of tissue was as follows:

"The gross specimen was 1.5 Gm. of reddish gray soft tissue and 1.5 Gm. of reddish gray bony spicules filled with honey-combing.

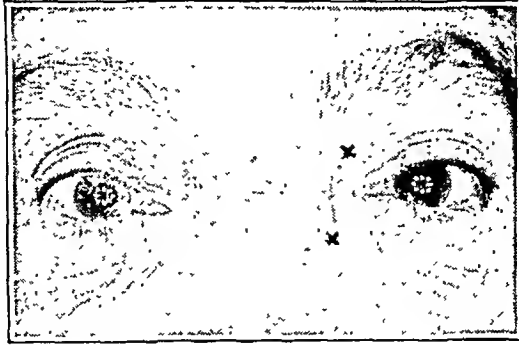


Fig. 2.—Healed scar of ethmofrontal operation on the left, six months postoperatively.



Fig. 3.—Low power photomicrograph, showing the inflammatory reaction at the border of the chondroma.

"Microscopic examination of the soft material was carried out on 5 sections. Cells with round nuclei containing granular blue chromatin and well defined nucleoli have a pink granular cytoplasm shrunken away from the cell wall. These cells appear to be secreting a dark and a light blue foamy material, which with the cells are enclosed in a collagen fibril envelope, overlying which is a covering of pseudostratified columnar ciliated epithelium. The collagen fibrils show spreading



apart in a few areas and infiltration of round and plasma cells in many areas. A few bony spicules infiltrated by dark blue material are also present.

"The specimens of decalcified bone were examined in 4 sections. The marrow of the bone shows proliferation of connective tissue and infiltration by nests of plasma cells. The dense connective tissue overlying the bone is heavily infiltrated by round cells. A few acini lined by cuboidal epithelium are embedded in the stroma, which is covered over by a pseudostratified ciliated epithelium. A portion of homogeneous substance, described in the preceding paragraph, lies contiguous to the bone.

"The pathologic diagnosis is chronic ethmoiditis and submucous chondroma." Photomicrographs of the sections of tissue are shown in figures 3 and 4.

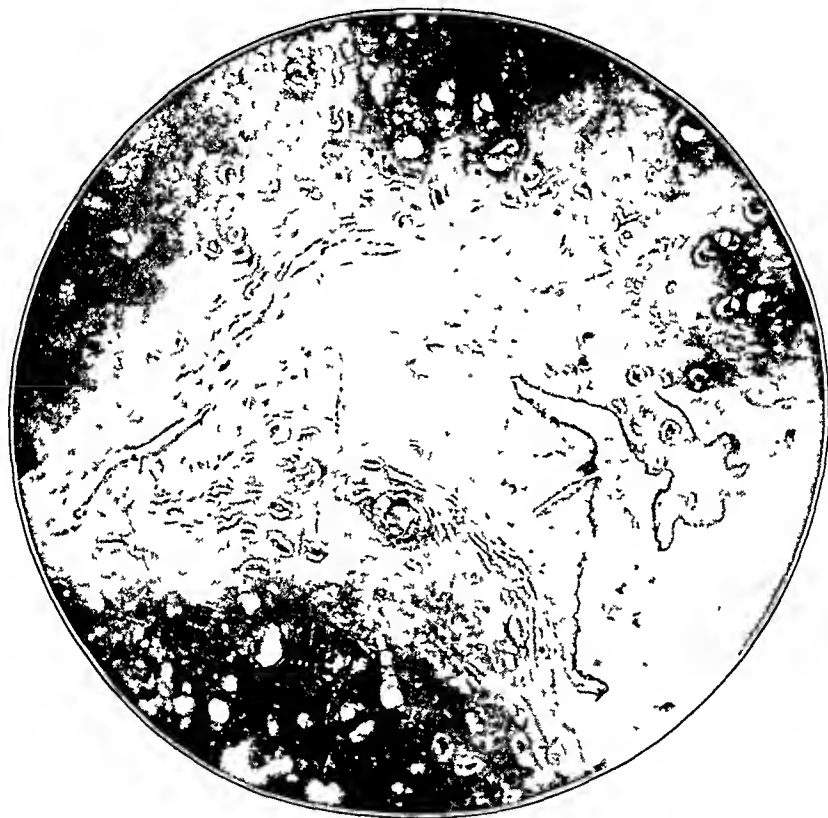


Fig. 4.—High power photomicrograph, showing the area of atypical cartilage comprising the tumor.

#### SUMMARY

Chondroma of the ethmoid, a rare intranasal tumor, is discussed and the rather limited pertinent literature reviewed. A case is reported in which the neoplasm was an important contributing factor in the production of orbital abscess and suppuration of the frontal sinus; operation resulted in an apparent cure of the original condition and all the related complications.

# CONGENITAL ATRESIA OF THE POSTNASAL ORIFICES

A SIMPLE, EFFECTIVE OFFICE TECHNIC FOR TREATMENT  
BY ELECTROCOAGULATION

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Congenital atresia of the postnasal orifices is due to the failure to disappear of normally occurring embryonic structures. The theories of its formation ascribe it to (a) the persistence of the bucconasal membrane, (b) the persistence of the buccopharyngeal membrane or (c) the overgrowth of the horizontal and vertical processes of the maxillas.

Schaeffer<sup>1</sup> described the formation and the disappearance of the bucconasal membrane as follows:

Thirty-five (35) day embryos show that the nasal pits have deepened sufficiently to partake of the nature of cleft-like fossae. . . . The fossae communicate freely with the exterior by means of the nares (anterior nares) but in the absence of choanae (posterior nares) end blindly at their dorsal and inferior termination. . . . The dorsal growth or extension of the blind, pouch-like primitive nasal fossae meets the ectoderm of the oral fossa. One now finds in these positions the bucconasal membranes composed of two layers of abutting epithelium (nasal and oral), separating the dorsal portion of the primitive nasal fossae from the oral cavity. In 35 to 38 day embryos the membranes are so attenuated that rupture ensues and the primitive choanae (primitive posterior nares) are thus established and with them communication between the nasal fossae and the oral cavity. Lack of rupture of the bucconasal membrane leads to atresia of the choanae. . . .

The amount of mesenchymal tissue remaining between the nasal and the pharyngeal mucous membranes determines whether the atretic mass is to be membranous, osseous or combinations of these. The thickness of the obstructing mass depends, of course, on the degree of dorsal growth of the nasal fossae and the extent of the resorption of the mesenchyme between the nasal and the pharyngeal epithelia.<sup>2</sup>

It appears certain that some thin, atretic membranes located in the region of the choanae rupture spontaneously during the early days of infancy, leaving little, if any, evidence of the obstruction.

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1. Schaeffer, J. P.: The Various Types of Congenital Atresia of the Nose and Their Genetic Interpretation, in the Nose, Paranasal Sinuses, Nasolacrimal Passageways, and Olfactory Organ in Man, Philadelphia, P. Blakiston's Sons & Co., 1920, pp. 7-10.

2. Schaeffer, J. P.: Various Types of Congenital Atresias of the Nose and Their Genetic Interpretation, Tr. Am. Laryng. A. **56**:126, 1934.

The choanae are bounded medially by the posterior border of the septum and the nasal crest of the palatal bone, above by the alae of the vomer and the body of the sphenoid bone, laterally by the median plates of the pterygoid processes of the sphenoid bone and the perpendicular plate of the palatal bone and below by the horizontal plate of the palatal bone.

Most writers agree that such choanal atresia is a congenital defect and not a pathologic condition. It is a comparatively rare developmental anomaly. The first occurrence was noted at necropsy by Otto, of Breslau, in 1829.<sup>3</sup> Emmert,<sup>4</sup> in 1853, first recognized and successfully operated to relieve bilateral choanal atresia, in a boy of 7 years. Since then the condition has been reported with increasing frequency, particularly during the past two decades, a tribute to the increased number of well trained workers in rhinology and to the more widely diffused knowledge that such a deformity may occur. At the present time nearly 200<sup>5</sup> cases have been recorded in the literature.

In the otorhinolaryngologic department of the Royal Infirmary of Edinburgh during twenty years (1907-1926) 27,863 patients were given nasal examinations and among these 6 (0.02 per cent) with unilateral atresia were found.<sup>6</sup> Congenital bilateral occlusion is more rarely reported because it often results in death from asphyxia at birth and thus remains unrecognized.

Stewart<sup>6</sup> reported on 2 patients with bilateral congenital atresia in one family, sisters 18 and 15 years old. An infant brother had died within forty-eight hours after birth, being bluish and dyspneic. It is likely, he stated, that his was a third case in the family.

Phelps<sup>7</sup> did not regard choanal atresia as hereditary, despite another recorded case, in which, in one family, a mother, her 2 sisters, 2 daughters and a son all had this malformation.

If unilateral or if bilateral but incomplete, the occlusion may escape detection by the patient, the parents and the examining physician for many years. Repeated adenoidectomies and occasionally ineffectual intranasal procedures have been carried out without the true nature of

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3. Otto, A. W.: *A Compendium of Human and Comparative Pathologic Anatomy*, translated by J. F. South, London, B. Fellowes, 1831; cited by von Schroetter.<sup>17</sup>

4. Emmert, C. F.: *Lehrbuch der Chirurgie*, Stuttgart, F. and R. Dann, 1853; cited by von Schroetter.<sup>17</sup>

5. (a) Lebensohn, J. E.: Congenital Atresia of Postnasal Orifices, *Ann. Otol., Rhin. & Laryng.* **32**:1128 (Dec.) 1923. (b) Cavanaugh, in discussion on Lebensohn.

6. Stewart, J. P.: Congenital Atresia of the Posterior Nares, *Arch. Otolaryng.* **13**:570 (April) 1931.

7. Phelps, K. A.: Congenital Occlusion of Choanae, *Ann. Otol., Rhin. & Laryng.* **35**:143 (March) 1926.

the occlusion being discovered.<sup>8</sup> On the other hand, complete bilateral occlusion can cause alarming asphyxia in the newborn. The instinct for nasal breathing in the newborn is so impelling that unless the mouth is forced open or the choanal occlusion is immediately broken through asphyxia may result. It is the opinion of many writers<sup>9</sup> that surely a number of the deaths listed as "asphyxia neonatorum" have been caused by unrecognized, complete, bilateral choanal occlusion. If an infant with bilateral choanal obstruction should somehow succeed in breathing through the mouth, the chances of its survival are lessened by interference with suckling and consequent malnutrition. Nevertheless, a standard textbook on obstetrics, by Williams,<sup>10</sup> and one on pediatrics, by Holt and Howland,<sup>11</sup> do not mention the condition. Had its possibility been kept in mind, many infant lives might have been saved.

In the newborn or in young infants, palpating with a probe or attempting to blow air through either nostril with a rubber bulb will help make the correct diagnosis. When the occlusion is membranous, rupture with a probe and dilation with the back of a small mastoid curet may give a satisfactory result.<sup>12</sup> In a case of unilateral occlusion, the mother may notice that the child can nurse only while lying on the obstructed side so that the patent nostril is above and not blocked by venous congestion caused by gravity. Complete stenosis of one or both nostrils in such young patients is never due to adenoids.<sup>8b</sup> This is important, as in some cases the true condition has been overlooked and the sufferer operated on three times for alleged adenoids.

Cavanaugh<sup>5b</sup> reported the case of a 12 year old child whose tonsils and adenoids had been removed, the latter on three occasions. The inferior and middle turbinates had been excised, and the attending physician was reported to have considered an operation on the ethmoid sinuses on the affected side of the nose. When the correct diagnosis of unilateral choanal atresia was finally made, the discouraged mother declined to permit the necessary operation.

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8. (a) Footnote 5. (b) Wright, A. J. M.: Congenital Bilateral Occlusion of Choanae, *J. Laryng.* **37**:556 (Nov.) 1922. (c) Colver, B. N.: Congenital Choanal Atresia: Two Cases of Complete Bilateral Obstruction, *Ann. Otol., Rhin. & Laryng.* **46**:358 (June) 1937.

9. (a) Footnote 5. (b) Clarke, J. P.: Complete Congenital Occlusion of the Posterior Nares, *Boston M. & S. J.* **138**:171 (Feb. 24) 1898. (c) Richardson, C. W.: Congenital Osseous Obstruction of the Post-Nasal Orifices, *Ann. Otol., Rhin. & Laryng.* **22**:488 (June) 1913. (d) Ronaldson, T. R.: Note on a Case of Congenital Closure of the Posterior Nares, *Edinburgh M. J.* **26**:1035, 1880-1881.

10. Williams, J. W.: *Obstetrics*, ed. 5, New York, D. Appleton and Company, 1924.

11. Holt, L. E., and Howland, J.: *Diseases of Infancy and Childhood*, ed. 9, New York, D. Appleton and Company, 1926.

12. Lemere, H. B.: Persistent Bucconasal Membrane in the New-Born, *J. A. M. A.* **109**:347 (July 31) 1937.

The sense of smell is diminished in unilateral obstruction, and anosmia occurs in the bilateral condition. Sense of taste is similarly diminished. The voice is nasal. Slight asymmetry of the face can be observed in cases of unilateral obstruction. The hearing may be affected in the bilateral condition.

The impervious nostril is often filled with thick, glary, tenacious mucus. This usually is mixed with the lacrimal secretion, which empties into the nose. The patient, being unable to blow the nose, is generally obliged to remove this discharge by syringing. When the patient cries, some of the tears flow out through the nose. When the head is tilted forward, as in eating, these secretions drip down through the nose, causing annoyance and embarrassment. Erosion of the nares and of the upper lip may be present. In the unilateral condition tobacco smoke can be exhaled through the patent nostril only. (This phenomenon was utilized by my patient as a parlor trick.) Of course, it is impossible to syringe fluids through the occluded nostril into the pharynx or into the other nostril or to force air through the blocked nasal passage with a rubber bulb. Postnasal examination by finger palpation, by a mirror or by a nasopharyngoscope passed through the mouth reveals the abnormality. Finger palpation is impossible in the average infantile throat.<sup>13</sup> If the obstructing tissue is visible from the front, it is seen to be pale and gray. In the postnasal mirror it may appear pinkish and often dimpled and perforated in the middle if the obstruction is incomplete. The nasal chambers are wide because of underdevelopment of the turbinates. The mucosa is paler than normal and is often waterlogged. The occluding wall, if bony, may be up to 12 mm.<sup>13</sup> thick and is usually situated near or even with the posterior margin of the vomer.

In differential diagnosis <sup>13</sup> the following conditions should be ruled out:

1. Adenoids.
2. Congenital postnasal polyp or tumor.
3. Intranasal occlusion due to polyps, bony and cartilaginous obstructions or new growths.
4. Cicatricial stenosis of the nasopharynx due to (a) tonsillectomy, (b) tonsillectomy and adenoidectomy, (c) hereditary syphilis, (d) acquired syphilis, (e) diphtheria, (f) rhinoscleroma, (g) tuberculosis, (h) caustic burns, for instance, by sulfuric acid, (i) indeterminate inflammatory processes, (j) non-operative trauma or (k) a foreign body in the nose.

Surgical opening of the bony occlusion is accomplished by the use of one or a combination of the following instruments: a Kraus trocar, an antrum drill, a nasal punch forceps, a dental burr or a chisel and

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13. Garretson, W. T.: Congenital Occlusion of Choanae, with Report of Two Cases, *Laryngoscope* 37:263 (April) 1927.

hammer. If a general anesthetic is used, the left forefinger inserted into the postnasal space touching the posterior surface of the obstruction acts as an invaluable guide in properly placing the instruments. This permits the complete destruction required without injury to the posterior nasopharynx or to the blood vessels and nerves lying just outside the lateral margin of the obstruction. It is a requisite for success to remove not only the occluding diaphragm but also a fair piece of the posterior margin of the septum. This expedient was first suggested by Katz.<sup>14</sup> It was successfully employed by White<sup>15</sup> in reoperating on a patient of his in whom the first opening he made was practically closed in three months. In removing the occlusion, care should be taken not to injure the pterygopalatine canal, which is situated just anterior to the choanal orifice, or the posterior palatine canal, situated just behind the opening in the outer wall. In older patients the normal osseous development around the choanal canal has been retarded. For this reason, special care must be exercised in working laterally to avoid injury to the blood vessels and nerves in the canals here situated.<sup>15a</sup> As much care as possible should be taken to prevent the aspiration of bone chips covered with blood.

With a local anesthetic, the employment of the left forefinger as a guide is not feasible, but there is some compensatory advantage in the material reduction of the danger of aspiration of bone chips. It is wiser to avoid enlarging the opening in the obstruction too much laterally, to insure the safety of the blood vessels and nerves located there.

All sorts of ingenious devices have been tried postoperatively in an effort to maintain the patency of the surgically made opening. Rubber tubes and obturators were left in place for many days; tubes of blocked tin,<sup>16</sup> molded to shape and inserted into the opening, were worn for six weeks. A long gauze strip covered with bismuth paste was looped through the opening from one side of the nose to the other. A fresh piece of such gauze, sewed to the end of the old, was pulled through the newly made opening and the dressing thus changed daily for ten days.<sup>16a</sup>

14. Katz, L., in Katz, L.; Preysing, H., and Blumenfeld, F.: *Handbuch der speziellen Chirurgie des Ohres und der oberen Luftwege*, Würzburg, Curt Kabitzsch, 1911-1913, vol. 3, p. 432; quoted by White.<sup>15</sup>

15. White, L. E.: An Operation for Bony Occlusion of the Posterior Nares, *Laryngoscope* **28**:571 (Aug.) 1918.

15a. Stinson, W. D.: Osseous Atresia of Posterior Choanae, *Arch. Otolaryng.* **15**:101 (Jan.) 1932.

16. Hubbell, A. A.: Congenital Occlusion of the Posterior Nares, *Buffalo M. & S. J.* **26**:5, 1886.

16a. Brady, A. J.: Atresia of the Choanae: A Simple Device for Prevention of Re-Formation of the Obstruction After Its Removal, *J. Laryng.* **33**:49 (Feb.) 1918.

Electrocautery was used as early as 1885.<sup>17</sup> Many chemical caustics, for example, potassium hydroxide and trichloroacetic acid, have been tried for some months after operation in an attempt to control the granulation and synechia. Clipping the edges of the opening with a sphenoid punch forceps has been advised for the same purpose. Recently, Donnelly<sup>18</sup> placed a full thickness skin graft stitched to a no. 18 woven catheter against the raw, bony surface of the choanal opening and left it in place for ten days.

Small wonder that such painful and prolonged postoperative procedures resulted in many accidents, such as infection of the middle ear, severe hemorrhage and even occasionally death. As has been stated, the failure of operations for bony choanal occlusion is due to the reformation of the occluding tissue, often in a few months. Since the operator encounters only 1 or 2 cases in a lifetime, he has scarcely the opportunity for observing and evaluating the different methods of operative procedure.

In sharp contrast with these surgical procedures, with their difficulties and frequent failure is electrocoagulation. It presents no dangers for the operator who is satisfied with treatments of limited objective. Practically no pain or bleeding either accompanies or follows treatments. Electrocoagulation permits the permanent destruction of the occluding wall with a minimum risk of cicatricial synechia. The purpose of this paper is not so much to report an additional case of unilateral atresia as to direct attention to a simple, permanently effective office technic of treatment by electrocoagulation. This method should in large measure replace the often formidable and too frequently unsuccessful surgical procedures commonly in use today.

In a search of the literature on choanal obstruction, the first use of electrocoagulation which I found was in 1922 by Bourgeois and Leroux.<sup>19</sup> This was in a case of incomplete membranous occlusion of the right choana of a girl 21 years old. Increasingly large olive-shaped electrodes being used, the periphery of the small opening was coagulated by diathermy. Five treatments, ten days apart, gave an excellent functional result, with respiration better than on the normal side of the nose when the patient was examined eight months later. The authors distinctly specified that the technic employed (300 to 350 milliamperes) is suitable only for membranous stenosis. They stated the belief that

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17. von Schroetter, L.: Ueber angeborenen knochernen Verschluss der Choanen, *Monatschr. f. Ohrenh.* **19**:97 (April) 1885.

18. Donnelly, J. C.: New Method of Operation for Congenital Atresia of Posterior Nares, *Arch. Otolaryng.* **28**:112 (July) 1938.

19. Bourgeois, H., and Leroux, L., cited by Bourgeois, H., and Poyet, G.: Traitement de certaines sténoses rebelles du nez et du pharynx par la diathermie, *Rev. de laryng.* **43**:883 (Nov.) 1922.

if the stenosis is mixed (osteomembranous) the destruction of only the membranous part may give a functionally excellent result without the necessity of operating on the bony part. The use of more than 400 milliamperes, they stated, makes control of the coagulation difficult.

Recent textbooks on diseases of the nose and throat, for example that by Ballenger<sup>20</sup> and that by Imperatori and Burman,<sup>21</sup> refer to this method. The latter authors expressed preference for electrocoagulation as compared with surgical intervention for membranous and osteomembranous occlusion. Chloroform is used for anesthesia.

A fine electrode, completely insulated except at the point, is passed backward through the nose, until it touches and perforates the occluding membrane.

The rubber covered palpating finger in the nasopharynx acts as a guide, while the current is turned on and the accessible membrane is destroyed.

If the mouth and throat are too small for the operator's finger, a flexible piece of metal covered with rubber or a bent piece of wood softened in hot water may be employed to protect the nasopharyngeal wall.

For infants and children, who cannot be treated under local anesthesia, this procedure undoubtedly is the method of choice in cases of membranous or osteomembranous occlusion. However, in a case of purely bony obstruction, unless the occlusion is thin, I do not believe that one treatment alone by electrocoagulation, even if extensive and severe, can give a satisfactory result. Rather, I am of the opinion that in such circumstances an opening of the obstruction made surgically and immediately followed by electrocoagulation of the cut edges, sponged as dry of blood as possible, would be more likely to remain open. I advise, in order to insure the permanence of the opening, repetition once or twice with chloroform anesthesia of the electrocoagulation of the cut edges after a three or four week interval.

Treatment of unilateral involvement can be deferred indefinitely until the best condition of the patient is attained. The program of delay is to be interrupted only if the patient's development or health is not satisfactory. Richardson<sup>9c</sup> expressed the opinion that it is hazardous to operate surgically before the patient is 2 years old. Syme<sup>22</sup> stated that an opening made before the expiration of the second year will not be permanent. Phelps<sup>7</sup> expressed the opinion that one may safely operate at any age and that the opening in most cases will prove permanent. In 90 per cent<sup>5</sup> of the cases, the occlusion, which may be as much as 12 mm.<sup>13</sup> thick, has been osseous, and it is usually com-

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20. Ballenger, W. L.: *Diseases of the Nose, Throat and Ear*, revised by H. C. Ballenger, ed. 6, Philadelphia, Lea & Febiger, 1930, p. 659.

21. Imperatori, C. J., and Burman, H. J.: *Diseases of the Nose and Throat*, Philadelphia, J. B. Lippincott Company, 1935, p. 638.

22. Syme, cited by Ballenger.<sup>20</sup>



plete. This being so, one treatment by electrocoagulation with general or local anesthesia, even if extensive and severe, as was noted, cannot succeed except when the bony occlusion is thin.

#### REPORT OF A CASE

Miss S. R., 18 years of age, consulted me in March 1937 concerning constant obstruction of the left nostril, inability to clear the left side of the nose of secretions and annoying dripping of these secretions out of this nostril when she bent her head forward, as while eating. She was the only one in a family of 7 with this nasal defect. She was 5 feet and 2 inches (157 cm.) in height and weighed 112 pounds (51 Kg.), being 5 to 6 pounds (2.3 to 2.7 Kg.) underweight. Externally, the dorsum of the nose was deviated from the left above to the right below. The left side of the face was slightly but definitely less fully developed than the right. The left palpebral opening was smaller than the right. During an attack of measles in childhood, an aural infection had required myringotomy twice on one ear. The drum healed without leaving any perforation. The patient and her mother could not recall which ear was involved. There were no other serious illnesses. The tonsils and adenoids had been removed following the aural infection. The throat showed a small amount of chronically infected tonsillar remnants. The hard palate did not show faulty development. The teeth were in fairly good condition; the ear drums were moderately thickened and slightly retracted on both sides, but more markedly on the left. Both ears heard all tuning forks from 32 to 2048 double vibrations, but responses of the right ear were more prompt. The 128 and 256 double vibration tuning forks being used, perception in the Weber test was referred to the left. The sense of smell, tested roughly with vinegar, purified petroleum benzin, methyl salicylate and ether, was good on the right side but completely lacking on the left. The right side of the nose was clear. The left nostril was filled with a watery suspension of tenacious mucus. There was no marked irritation around the anterior nares on the left side. The nasal septum was deviated to the left side above. The mucous membrane of the left side of the nose was pale with a bluish tint. The left middle and inferior turbinates were swollen. After cleansing, no nasal respiration whatsoever through the left nostril was possible. On shrinkage of the mucous membrane with cocaine, bony underdevelopment, particularly of the left inferior turbinate, was found.

Posterior rhinoscopic examination was difficult because of gagging, even after cocaineization of the pharynx. Repeated glimpses disclosed complete choanal obstruction on the left side. Far back, complete transverse, choanal, bony obstruction could readily be palpated with a probe.

Transillumination showed the left frontal sinus and antrum to be smaller than the right, but all were clear.

Röntgen examination revealed marked underdevelopment of the left frontal sinus. The left antrum was somewhat smaller than the right. All the sinuses were clear. Four unerupted and impacted third molars were present.

*Treatment.*—The nose first was cleansed of its accumulated discharges. The left side of the nose was anesthetized by packing with a 2 per cent solution of cocaine in physiologic solution of sodium chloride to which was added 0.3 per cent phenol. This permitted inspection and palpation with a probe to delineate the extent of the firm, bony obstruction. Because of the underdevelopment of the left turbinate bone and the greater roominess, this was readily done.

The electrode used was a rather stiff, steel cotton applicator 6 inches (15 cm.) long, the handle of which was filed down to fit the shank of the electrode holder. This was bent about 30 degrees in order to permit better illumination of the field. Thin rubber tubing was slipped over this to serve as an electric insulator. One-quarter inch (6.25 mm.) of the tip of the electrode was left bare. The electrode was applied firmly but not forcibly to the lower septal margin of the choanal obstruction and the current turned on for a moment with a foot switch just as is done in the electrocoagulation of a tonsil. A current of 2,500 milliamperes when short circuited was used. This was the equivalent of 250 to 300 milliamperes with the patient in the circuit. Five or six spots immediately surrounding the first area were similarly coagulated.

Scarcely any pain was caused by this procedure. At first,  $\frac{1}{2}$  grain (0.3 Gm.) of phenobarbital was given shortly before treatment, but subsequently this was found to be unnecessary. There was slight oozing occasionally but no bleeding at any time. The reaction to the treatments was never annoying enough to keep the patient from her daily work in a business office. It was not found necessary to use packing after treatment.

One week later, when the patient came for the second treatment, the accumulated nasal discharges were again removed. After cocainization, five or six spots surrounding the area first treated were coagulated.

At the third treatment, a week later, while the first area was again coagulated, the electrode easily perforated the bony obstruction. The patient was delighted to breathe through the left nostril for the first time in her life. A piece of absorbent cotton moistened with cocaine solution was pushed through this perforation and observed with a postnasal mirror. This served for orientation in placing the electrode safely while coagulating laterally and superiorly. The thickness of the bony choanal obstruction as palpated by the electrode was approximately 7 mm. Once a perforation was made, the end of the rubber tubing insulator proved a useful guide in placing the tip of the electrode around the periphery of the opening for further coagulation.

At the fourth treatment, the accumulated discharges in the left side of the nose were surprisingly reduced. The formerly pale mucous membrane had become pink, and the patient was still breathing through the small opening made on the left side. The nose was cocainized as usual, and, in addition, a small bit of absorbent cotton moistened with cocaine was again pushed through the choanal perforation. To enlarge the opening, a second electrode was made to coagulate the posterior surface of the choanal obstruction. This was similar to the first electrode except that the uncovered terminal  $\frac{1}{4}$  inch (6.25 mm.) was bent at right angles to the length of the instrument. The rubber tubing insulator was slipped  $\frac{1}{4}$  inch (6.25 mm.) from this right angle toward the shank of the electrode holder. This electrode was inserted through the perforation and turned toward the septal margin of the posterior surface. Firm forward pressure was employed while the current was turned on for a moment by the foot switch. The electrode was then rotated downward and similarly applied to enlarge the inferior margin of the opening. The first electrode was used on the anterior surface to coagulate points opposite these. This additional procedure caused the patient no more inconvenience than the former. The upper and particularly the lateral borders of the opening were enlarged last of all, to avoid injury to the blood vessels and nerves in the sphenopalatine and pterygopalatine canals. The choanal obstruction was thicker at its periphery than in the center. Persistent coagulation directed to the posterior margin of the septum destroyed nearly  $\frac{1}{4}$  inch (6.25 mm.)

of its anterior-posterior length. It is important to stress that in order to obtain the largest possible opening consistent with safety, correct orientation in placing the electrode must be secured. This can be confirmed by inspecting with a postnasal mirror the absorbent cotton protruding through the perforated choana.

There were eight treatments in all, the last three of which were given fortnightly. The patient returned for observation at irregular intervals of several months. The nasality of her voice has decreased. Her weight has increased. There are no discharges in the nose. The sense of smell was tested in the left nostril with the same substances as before and was found to be good, although not so acute as in the right side of the nose.

It is now more than two and a half years since this work was completed. At no time, either during the course of treatments or subsequently, has there been any granulation with which to contend. The size of the choanal opening has remained permanent. The patient now breathes more freely through the left nostril than through the right.

#### SUMMARY

It is important again to emphasize to the obstetrician, pediatrician and general practitioner the fact that posterior congenital atresia exists and may be the cause of asphyxia in the newborn, requiring immediate relief.

In the report of the case here presented, the following points are noteworthy:

1. Failure of the left frontal sinus to develop.
2. Absence of chronic sinusitis on the left side or of any but the slightest aural involvement despite complete closure of the left side of the nose since birth.
3. Absence of thoracic deformity, arching palate or narrow nostril, which are frequently attributable to partial stenosis of the nose.
4. Conservation of the sense of smell of the left olfactory nerve after eighteen years of disuse.
5. Diminution of nasality in voice after treatment.
6. Subsequent increase in the weight and well-being of the patient.
7. Permanent and completely successful result obtained by a series of simple office treatments without loss of time to the patient, contrasting with the frequent failures and difficulties of surgical methods followed by prolonged and painful after-care.

433 Eastern Parkway.

# Case Reports

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## UNUSUAL CASES OF THROMBOSIS OF THE SIGMOID SINUS

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The pathogenesis, course, diagnosis and treatment of the complication of mastoiditis with which this paper deals have been known for many years. However, the tendency in the literature has been to singularize and typify the clinical picture. There is no doubt that a characteristic syndrome is encountered in the majority of cases of sinus thrombosis, but it is the purpose of this paper to stress the fact that in many of these cases the behavior is not according to the rule.

It was in 1919 that Tobey<sup>1</sup> wrote:

The terms "typical" and "atypical" as applied to cases of lateral sinus thrombosis should be discarded from the literature, since they are most misleading. . . . I feel justified in making the statement that the textbook so-called "typical case" is very rare, and the otologist must be taught that each case is a problem unto itself, and that the picture is rarely complete.

Four years earlier, Day<sup>2</sup> reported spontaneous cure in 6 cases of unrecognized sinus thrombosis accidentally discovered during operation. From the standpoint of clinical findings, he classified cases of thrombosis of the lateral sinus into three general groups. The first group included the usual type of case, in which septic emboli are disseminated from the disintegrating thrombus in the sigmoid part of the lateral sinus. In the second group of cases the peripheral and central extremities of the thrombus become organized and remain sterile, and the center breaks down to drain through a rupture of the sinus wall. In the third the thrombus remains sterile, organizes and eventually obliterates the sinus.

Day's third group is typified by the following case:

CASE 1.—J. M. M. was 11 years old when first seen, on Nov. 20, 1928. At the age of 6 years she had scarlet fever followed by drainage of the left ear for one month. Nothing is known of the severity of this illness, but the patient experienced transitory earache on the left side without discharge at the age of 10 years. One month prior to being seen in 1928, earache had developed on the left side; a myringotomy had been performed, and the ear had drained pus intermittently since that time. A postauricular abscess was drained shortly after the myringotomy. On examination, the left tympanic membrane appeared retracted, dull and intact, while the postaural incision was draining profusely. Roentgenograms showed diffuse

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The patients here reported on were treated in the otologic service under Dr. A. C. Furstenberg at the University of Michigan Hospital at Ann Arbor, Mich.

1. Tobey, G. L., Jr.: Lateral Sinus Thrombosis, *Tr. Am. Otol. Soc.* **15**:161-181, 1919.

2. Day, E. W.: Report of the Spontaneous Cure of Six Cases of Unrecognized Lateral Sinus Thrombosis Accidentally Discovered During Operation, *Laryngoscope* **25**:757, 1915.

clouding of the left mastoid without definite evidence of destruction of bone. Two days after admission mastoidectomy on the left side demonstrated destruction about the antrum and in the floor of the mastoid. A large perisinus abscess was discovered; the sigmoid sinus was covered with granulations and was firm on palpation, while the wall of the sinus was incised and a clean organized thrombus found. No sepsis occurred, either before or after the operation; the wound healed satisfactorily, and the patient was discharged on Jan. 13, 1929.

This patient demonstrated an asymptomatic chronic thrombosis which was sterile, and there are no means of determining its age.

More recently, some of the European otologists have been describing intermittent, progressive and chronic types of thrombosis of the sigmoid sinus. Typical of these European writings is the report by Gerlach<sup>3</sup> of 3 attacks which lie intermediately between the completely afebrile and the acute fulminating type. In these attacks an intermittent fever accompanied by a chill occurred but a few times and at intervals of one, two or even three weeks, with the intervals completely symptom free. Such attacks may extend over three or four months, he said.

The next case to be reported falls into the group described by Gerlach<sup>3</sup> and first stimulated my interest in the unusual cases of sinus thrombosis.

CASE 2.—F. L., aged 58, was first seen on Feb. 28, 1935. Five weeks earlier a cold in the head had developed, with earache on the right side. Myringotomy had been performed, and the ear had drained steadily, although there had been no pain, headache, fever or vertigo. The right canal was found to contain thick mucopus; the tympanic membrane was dull and injected and had a central perforation through which some granulations projected. The region of the mastoid was tender to pressure over the antrum and the tip. Roentgenograms showed acute mastoiditis on the right side, with destruction of intercellular walls in the post-sigmoid area. When the patient was admitted to the hospital the following day, the temperature, pulse, respirations and blood were normal.

On the day following admission (March 2) mastoidectomy was performed on the right side and a pneumatized mastoid with coalescent mastoiditis found. The dura and the sigmoid sinus were exposed and appeared normal. The postoperative course was entirely uneventful, and the patient was discharged on the seventh postoperative day with a dry middle ear, a small perforation in the tympanic membrane and the postaural wound almost healed.

Five days after being discharged, he experienced a chill and a rise of temperature to 103 F., with pain appearing in the right parietal area. Three days later a second chill occurred, with a rise of temperature to 104 F., and he was readmitted to the hospital. Both tympanic membranes were intact and nearly normal, although the postaural wound was not entirely healed. The white blood cell count was 14,300, and a blood culture showed *Pneumococcus* type III. The temperature on admission was 103.5 F., but between March 18 and 27 it rose but once to 102 F., on March 22. Roentgenograms of the mastoid did not show evidence of petrositis or any mastoid cells remaining. Although the patient complained of frontoparietal pain on the right for a few days, this subsided spontaneously. No growth developed in a blood culture taken on March 21, and the patient insisted on leaving the hospital on March 27.

3. Gerlach, H.: Chronische Sinusthrombosen, *Ztschr. f. Hals-, Nasen- u. Ohrenh.* 39:262-280, 1936.

He was returned in a semicoma on April 3, and a history of chills and fever on the preceding four days was obtained. His temperature was normal on the day of admission, and no growth developed in a blood culture taken on the day following admission. The usual agglutination reactions were negative, and the white blood cell count was 14,300. The chief complaint now was temporo-parietal pain on the right side, accompanied by sharp elevations of temperature to 103.5 and 104 F. on April 7 and 9. The pneumococcus grew in a blood culture taken on the ninth, but one taken on the tenth was sterile, although the condition was poor. From April 11 to 25, the temperature was essentially normal, and the patient improved greatly. There was one more rise in temperature, on April 22, followed by gradual improvement. On May 6 the temperature, pulse rate and respiratory rate rose to 108 F., 150, and 40, respectively, and the patient went into a coma, from which he did not recover. Fulminating purulent meningitis, with *Pneumococcus* type III cultured from both blood and spinal fluid, was found. Continuous drainage of the spinal fluid was started, and the patient died on May 8, two months and four days after the complete mastoidectomy.

Ophthalmologic, medical and neurologic examinations were made frequently and gave negative results until the onset of the meningitis. The patient died on the sixty-seventh postoperative day. During that interval five blood cultures were taken, an attempt being made to get blood for culture near the peak of the intermittent fever, with a positive culture twice and no growth three times. There were eleven known sharp rises of temperature, and the remainder of the time the temperature was essentially normal. This case has not been duplicated in a busy otologic service during the past four years.

Unsuspected sinus thrombosis has been found at operation with both acute and chronic mastoiditis, and examples of this finding are seen in the following 2 reports.

CASE 3.—A. F., aged 10 years, had an infection of the upper part of the respiratory tract, with malaise and anorexia as the most striking symptoms but with no aural complaints, early in March 1932. She was first seen on April 26, when the right tympanic membrane was dull and thick. The following day myringotomy was performed, and the middle ear was found to be dry. The white blood cell count was 17,250. A subperiosteal abscess developed suddenly on the right side six days later, and complete mastoidectomy on the right side on May 3 demonstrated extensive necrosis of the bone. A perforation was found in the parietal wall of the sigmoid sinus and considerable pus in the softened thrombus, obliterating the lumen. Free bleeding was obtained from the end nearest the torcular Herophili but not from the bulb. Culture of the pus demonstrated hemolytic streptococci. Convalescence was slow but progressive, and at no time was there any significant elevation of temperature. The patient was discharged three months after operation with both the tympanic membrane and the postauricular wound healed.

CASE 4.—J. N., 42 years old, had suffered otorrhea on the left side for twenty years. The discharge ceased and pain developed over the left side of the head on Sept. 16, 1932. He was seen one week later. A foul discharge was present in the left canal, and a large polyp occluded the perforation in the tympanic membrane. Marked tenderness to pressure was observed over the lower half of the mastoid. The patient did not have chills. The temperature on admission was 104.5 F., and within a few hours he became irrational. Roentgenograms

showed contracted sclerotic mastoid processes bilaterally, and radical mastoidectomy was performed on the left side on September 24. The cellular development was limited to the periantral region, and a large perisinus abscess was found, while the parietal wall was necrotic and the contained thrombus was firm and well organized. The patient continued a septic course, and three and four days after operation the left and right eyes became proptosed, death occurring six days after the radical mastoidectomy. Postmortem examination revealed bilateral thrombosis of the cavernous and sigmoid sinuses, acute purulent leptomeningitis and hematogenous confluent lobular pneumonia with abscesses and early gangrene.

This patient had well organized chronic sinus thrombosis eight days after the first symptom of the acute exacerbation of the chronic mastoiditis and died of acute leptomeningitis six days later.

Cases 3 and 4 probably fall into Day's second group, in which the ends of the thrombus are sterile and organized, so that embolism does not occur, but the center drains itself into the mastoid by rupturing the parietal wall of the sigmoid sinus. Here again, one cannot begin to postulate the age of either thrombus.

CASE 5.—G. F., aged 11 years, was first seen on April 20, 1933, with a history of intermittent bilateral otorrhea present for two years. On the first examination, the perforation in the left tympanic membrane was dry; there was some purulent discharge on the right, and a polyp was removed to improve the drainage. The right ear continued to drain, and on July 24 the boy had pain in the ear, with a high temperature and pain over the right side of the head developing in twenty-four hours. On July 29 he had a chill, and projectile vomiting and stiffness of the neck developed. He was admitted to the hospital on July 31, at which time the right canal contained some foul pus, the tympanic membrane was pink and retracted, with a small central perforation, and there was tenderness to pressure over the right internal jugular vein. Ophthalmologic and neurologic examinations gave negative results, and a blood culture did not show any growth.

Radical mastoidectomy was performed on the right side on August 2. The sigmoid sinus was flat and dull. Before the operation on the sinus, the neck was opened; the internal jugular vein was found to be thrombosed to its junction with the subclavian, and a ligature was applied at this junction. The lateral sinus was then opened and found to be filled with an infected old clot, while free bleeding was not obtained from either end. Culture of the pus inside the sinus demonstrated *Bacillus coli*. The condition of the patient was satisfactory on the first postoperative day, but on the second the temperature rose to 104 F. and the respiratory rate to 40, with physical findings of pleural effusion and pneumonia, and *B. coli* was cultured from the sputum. Empyema and pulmonary abscess developed, while closed and open drainage of the empyema occurred, and eventually the lower lobe of the right lung was excised for the abscess. The mastoid cavity healed satisfactorily, and the patient was last seen on March 12, 1936, with the cavity of the radical mastoidectomy in good condition, healed wounds from the mastoidectomy and the operation on the neck and a healed lobectomy scar.

Here the chronic sinus thrombosis was demonstrated nine days after the onset of the acute exacerbation, and the thrombosis was of unknown age. An unusual organism, *B. coli*, was involved, and the patient ran the gamut of thoracic surgical treatment before recovery.

In the next 2 cases to be described, actual cholesteatoma was found in the lumen of the sigmoid sinus.

CASE 6.—In R. P., aged 23, otorrhea developed on the left side in 1925, which continued until he first came to the hospital in 1933. Mastoidectomy had been done in 1931 without relieving the otorrhea, and on July 4, 1933, severe pain developed in the left ear, with nausea and vomiting two days later and the next day a severe chill. When the patient was admitted to the hospital, on July 7, the temperature was 106 F., with a foul discharge in the left canal, marked drooping of the posterior superior quadrant of the external auditory canal and marked tenderness to pressure over the mastoid. A central type of palsy of the left facial nerve was present, although the disks were not choked and the remainder of the neurologic examination gave negative results, while the leukocyte count was 17,250.

On July 8 complete mastoidectomy was performed on the left, and extensive excavation of the mastoid by the cholesteatoma was encountered. The parietal wall of the sinus was eroded, and the lumen contained cholesteatoma and an old organized thrombus, although free bleeding was obtained from the end nearest the torcular Herophili. The patient died the following day. Postmortem examination was not permitted.

CASE 7.—G. P. was 38 years old when first seen, on Nov. 5, 1931. He had suffered from intermittent otorrhea on the left side since childhood, and at this time fever and chills had been present for three days. On admission the temperature was 106.2 F., the left canal was filled with foul pus and there was a furuncle in the canal which shut off all view of the tympanic membrane. Neurologic examination gave negative results, and radical mastoidectomy was performed on the day of admission by the late R. B. Canfield. The middle ear and antrum were filled with cholesteatoma, although the sigmoid sinus did not appear particularly abnormal. A septic course continued, and a week later the patient was again operated on, when the jugular vein was found to be collapsed above the facial vein and was ligated. The sigmoid sinus was opened and found filled with cholesteatoma, and free bleeding was obtained posteriorly. The cerebellar dura was bulging and was incised, plastic exudate on the leptomeninges being encountered. On November 24 the patient became comatose; proptosis of the left eye developed, and thrombosis of the cavernous sinus was diagnosed, his death occurring on the following day.

Throughout his stay in the hospital the patient was septic, but the white blood cell count was never above 15,800 on seven examinations, and three blood cultures were negative. A streptococcus was cultured from the mastoid and the lumen of the sigmoid sinus.

These 2 patients must have had their sinus thrombosis for months or years to account for the cholesteatoma present in such large amounts in the lumen of the sigmoid sinus, although neither of them showed any signs or symptoms of serious complications of the mastoiditis until a comparatively few days before death.

CASE 8.—This last and interesting case was that of a private patient of Dr. A. C. Furstenberg, who has given me permission to include it among these unusual cases of thrombosis of the sigmoid sinus. J. G., aged 10 years, is a physician's son. A preauricular abscess was drained on Jan. 1, 1938, and a complete mastoidectomy on the right side followed on January 5. On January 13 complete mastoidectomy was performed on the left side, and the right sigmoid sinus was exposed; it appeared to be normal but was needled and blood obtained. The boy had a convulsion on the next day, but there had not been any chills. He had a mild daily elevation of temperature; his general condition did not improve, and it was at this time that the boy was brought to Ann Arbor and placed under Dr. Furstenberg's care.



Ophthalmologic and neurologic examinations on the day of admission did not yield new information, and a roentgenogram of the chest was normal. The white blood cell count ranged about 16,000 daily, and there was little rise in temperature. The wounds were in satisfactory condition, and the boy seemed to be improving.

On February 10 two clonic convulsions occurred on the left side, followed by left hemiparesis. Left temporal homonymous hemianopia and left astereognosis were discovered, and the next day the neurosurgical consultant, Dr. Max M. Peet, trephined the skull and needled the right temporal lobe but did not find an abscess. A ventriculogram was made, showing only moderate dilatation of all ventricles. The temperature went to 104 F. on the tenth and eleventh and then decreased once more. Forty-eight hours later the mastoidectomy wound on the right side was opened, and free pus was found in the sigmoid sinus. Bleeding was obtained posteriorly but not from the bulb, and the internal jugular vein was ligated. Between February 10 and 23 the patient received 38 Gm. of sulfanilamide by the oral and the intravenous route and showed progressive improvement, being discharged without neurologic signs on March 6.

This patient showed definite localizing signs of an abscess of the right temporosphenoid lobe, yet aspiration of the brain failed to demonstrate this condition. Thrombosis of the sigmoid sinus, in the absence of chills, repeated high temperature or a positive blood culture, was found, while the neurologic findings subsided and the patient recovered after obliteration of the sigmoid sinus and ligation of the internal jugular vein. This is the first case in Dr. Furstenberg's experience in which definite localizing signs of abscess of the brain have been produced by thrombosis of the sigmoid sinus.

These experiences are all far from the usual picture of thrombosis of the sigmoid sinus, showing that the thrombosis may be entirely asymptomatic and found only accidentally, at mastoidectomy. The thrombosis may seal itself off at both ends, precluding embolic phenomena and drain itself by destroying the parietal wall of the sigmoid sinus; cholesteatoma may be found in the lumen of the lateral sinus. The old dictum that meningitis, abscess of the brain and thrombosis of the sigmoid sinus can each simulate the others is recalled by the last case, in which thrombosis of the sigmoid sinus apparently produced localizing signs of abscess of the temporosphenoid lobe.

# PRIMARY MIXED CELL MYELOMA OF THE MOUTH INVOLVING THE ANTRUM

ROBERT F. ROH, M.D., NEWARK, N. J.

This case is reported because of the unusual pathologic picture in a primary tumor of the superior maxilla. Other cases of plasma cell tumors about the head and neck without skeletal involvement have been reported.<sup>1</sup> So far as I am aware there are but few cases of such a tumor originating about the alveolar process.

Myelomas are considered most commonly to be tumors of the bone marrow which show multicentric foci of origin and produce certain characteristic roentgenologic changes in the bone involved. In addition, certain findings in the blood and urine are, as a rule, more or less commonly associated with the disease.

Histologically the new growths may vary in appearance from case to case and even from point to point within the same tumor. Study of numerous sections, however, almost invariably reveals collections of plasma-like cells with eccentric nuclei, which are the most significant and pertinent factor in making a microscopic diagnosis.

Proceeding from this characteristic picture one finds scattered reports in medical literature which deal with localized growths which have a microscopic picture similar to that of multiple myeloma but whose somatic behavior is apparently different. These tumors occasionally appear to arise from the soft tissues, remain localized and act in a relatively benign fashion.<sup>2</sup> On the other hand, metastases may occur, and the course of the growth may be that of a typical lymphosarcoma of the more malignant variety.

The following case is one in which a myeloma arose within the maxilla and involved the antrum and mouth and after its removal a new focal point of origin of tumor tissue was found in the mandible.

## REPORT OF A CASE

Mrs. M. C., aged 71, was admitted to the hospital on Feb. 10, 1939. Four days previously her physician had been called because of a small swelling on the upper right alveolar border. The patient described the swelling as a "gum boil" and

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Read at a clinical meeting of the Academy of Medicine of Northern New Jersey, Newark, N. J., Oct. 2, 1939.

1. Claiborn, L. N., and Ferris, H. W.: Plasma Cell Tumors of the Nasal and Nasopharyngeal Mucosa, *Arch. Surg.* **23**:477 (Sept.) 1931. Jackson, H.; Parker, F., and Bethea, J. M.: Studies of the Diseases of Lymphoid and Myeloid Tissue: II. Plasmacytomata and Their Relation to Multiple Myelomata, *Am. J. M. Sc.* **181**:169, 1931. New, G. B., and Harper, F. R.: Plasma Cell Myeloma of the Pharynx and Cervical Region Without Skeletal Involvement, *Arch. Otolaryng.* **16**:50 (July) 1932. Pollock, F. J.: Plasmacytoma of the Nose and Nasopharynx, *ibid.* **19**:311 (March) 1934. Cooper, K. G.: Plasmacytoma and Rhabdomyoma of the Paranasal Sinuses, *ibid.* **20**:329 (Sept.) 1934. Blumenfeld, L.: Plasma Cell Tumors of the Nose and Nasopharynx, *Ann. Otol., Rhin. & Laryng.* **45**:436, 1936.

2. Ewing, J.: *Neoplastic Diseases*, ed. 3, Philadelphia, W. B. Saunders Company, 1928, p. 420.

said it had been present for about two months. Because the swelling looked and felt like an abscess the doctor incised it and immediately was greeted with a profuse hemorrhage, which he stopped with great difficulty and then only after the use of packing. He said the packing seemed to go into a deep cavity. On three successive days the bleeding returned. The patient was weak and anemic from loss of blood and was brought to the hospital for better control of any future hemorrhage.

On February 16 a roentgen examination of the maxillary bones (fig. 1) revealed evidence of a destructive lesion involving the inferior border of the right maxilla and a soft tissue tumor in that region. Biopsy was advised. On February 21 a superficial specimen was taken for biopsy, and the tissue from this specimen was diagnosed as chronic suppurative inflammatory tissue. At that time what was thought to be a gastrointestinal disturbance or one of the gallbladder developed, and it was impossible for the patient to retain food. Dextrose was given intra-



Fig. 1.—Plain roentgenogram of the antrums.

venously, and for two weeks the general physical condition demanded more attention than the tumor in the mouth. On March 2 I first saw the patient. She was obese but looked rather exhausted from her periods of vomiting and loss of blood. She had no pain about the face, the nose was free of mucus, with normal turbinates and lateral nasal walls; there was no nasal or postnasal discharge. No cervical glands were palpable. All teeth had been removed one and a half years before. The mass in the mouth appeared nearly as large as seen in figure 2; it was soft and smooth, with an ulcerated area at the site of the removal of the specimen for biopsy. The growth seemed most probably to be malignant, and after a Wassermann test was made, which was negative, its radical removal, including resection of the superior maxilla, was suggested. Both the attending physician and the patient felt the procedure was rather formidable and were inclined to believe that she would not survive such treatment. I certainly was not so sure that she would and so did not press the matter. Transfusions were given on March 6 and March 15, and after further deliberation it was mutually agreed to proceed with the operation. On March 22 Dr. Henry Orton kindly consented to see the patient and made the suggestion that iodized poppyseed oil should be instilled to further the study of the involvement within the antrum. Figure 3 shows the

result of this examination, made on March 24, outlining a mass which nearly filled the antrum. The iodized poppyseed oil was instilled through the natural ostium. Considering the extent and low location of the tumor within the antrum I believe that injection through the usual route, that is, the inferior meatal,



Fig. 2.—Tumor as it extended into the mouth.

would not have given such good results and probably would have precipitated profuse bleeding because of puncture into the tumor.

Preliminary ligation of the right external carotid artery was done on March 25, which the patient withstood remarkably well under cyclopropane anesthesia. Three days later, with the patient under anesthesia induced by nitrogen monoxide, oxygen and ether, the right superior maxilla was partially resected and the

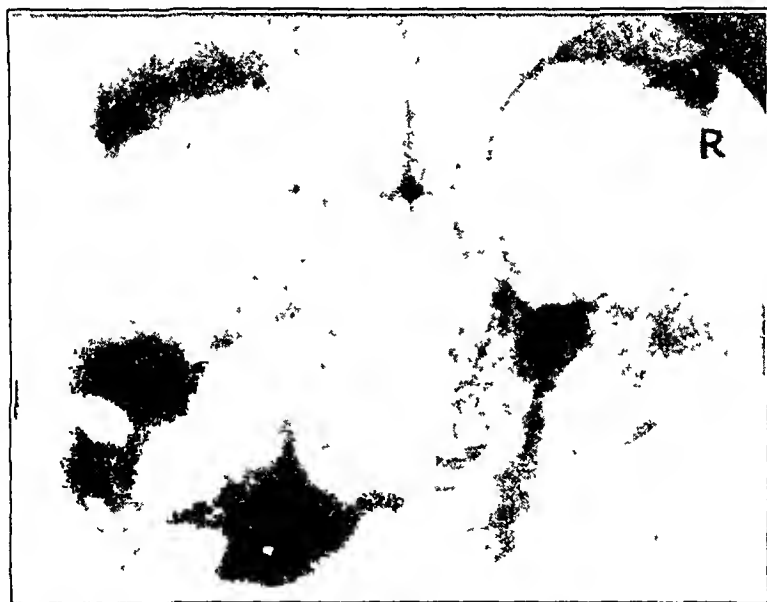


Fig. 3.—Roentgenogram of the antrums after the injection of iodized poppyseed oil into the right antrum.

tumor totally removed. The tumor appeared to emanate from the right upper alveolar border and extended into the mouth about 2.5 cm. The upward expansion almost entirely filled the antrum, within which it was soft and smooth, with a bluish membrane that looked like a sac. This was easily dislocated from the antral walls and removed through the opening previously made in the floor of the antrum.

The histologic examination of the tumor (fig. 4) showed a cellular new growth with a minimal supporting stroma. The component cells varied in appearance in different parts of the growth. In some areas they were small with deeply staining, granular and eccentric nuclei resembling plasma cells. In other areas they were larger with clear cytoplasm and vesicular nuclei and were suggestive of a granulocytic origin. In the latter areas were present also large cells with multilobed nuclei and acidophil nucleoli.

The tumor was vascular and showed numerous areas of necrosis and interstitial hemorrhage. Sections stained with hematoxylin and with eosin were submitted to Dr. F. W. Stewart, of Memorial Hospital, New York, and portions of the specimen were sent to Lt. Col. J. E. Ash, of the United States Army Medical Corps. Both these authorities agreed that the neoplasm was a myeloma.

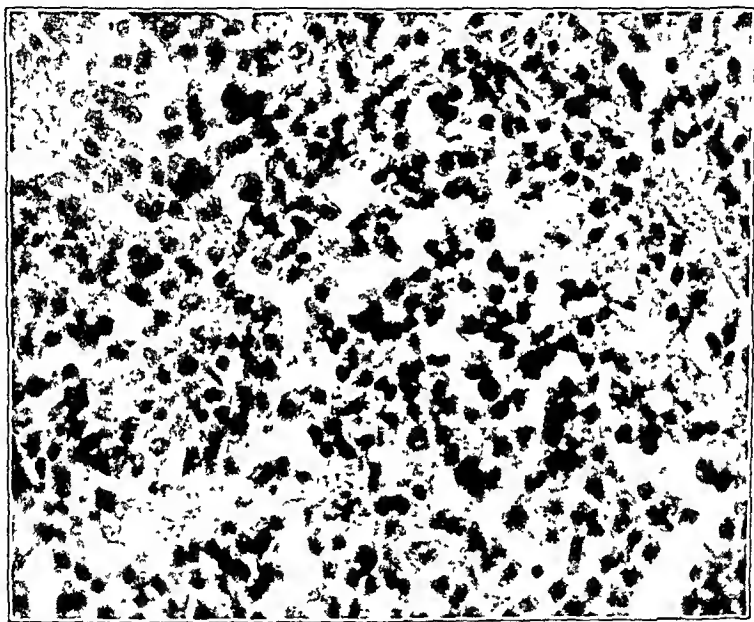


Fig. 4.—Photomicrograph of a section from the right maxilla showing numerous characteristic plasma cells, with eccentric hyperchromatic nuclei ( $\times 600$ ).

Consultations from roentgenologic and radiologic standpoints were held with Dr. W. J. Marquis and Dr. M. J. Friedman, and a program of further examinations and treatments was worked out.

A sternal puncture was performed on April 13, and examination of the bone marrow (fig. 5) revealed erythropoietic hyperplasia without evidence of atypical cell proliferation. On April 18 roentgenologic studies were made of the skull, spine, sternum, ribs and pelvis. Evidence of lesions resembling multiple myeloma was not found.

Examination of the urine showed a specific gravity ranging from 1.009 to 1.018. All the specimens contained albumin (2 plus) and at no time could Bence Jones protein be detected. Numerous pus cells and occasional hyaline casts and red blood cells were present.

The blood count showed a hemoglobin content (Newcomer) of 43 per cent, and the erythrocytes numbered 3,000,000 per cubic millimeter. There was no

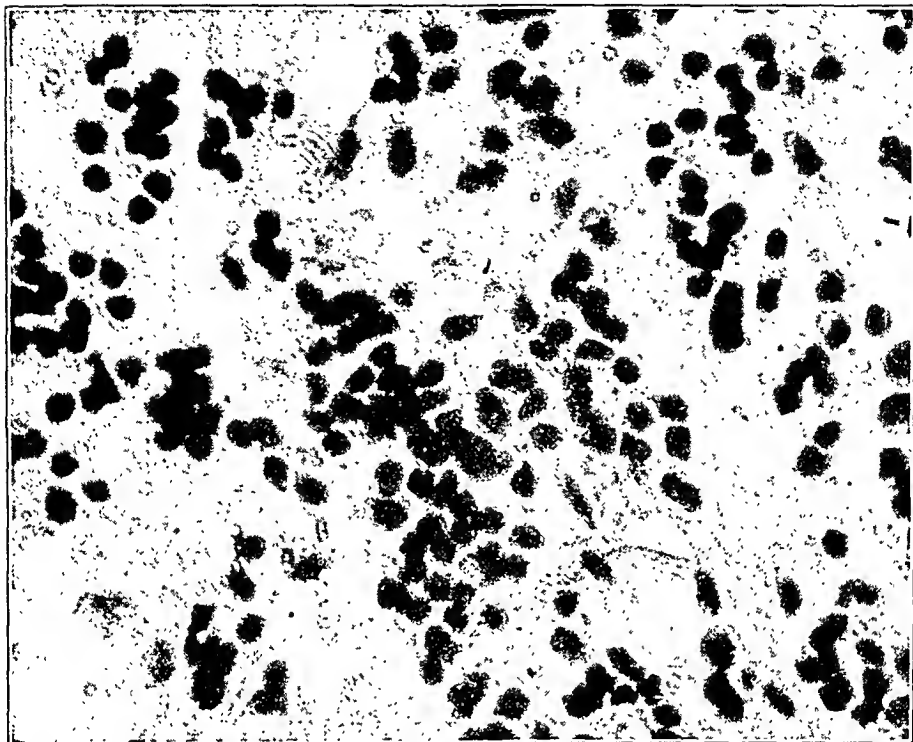


Fig. 5.—Bone marrow—no atypical cells evident (high power).

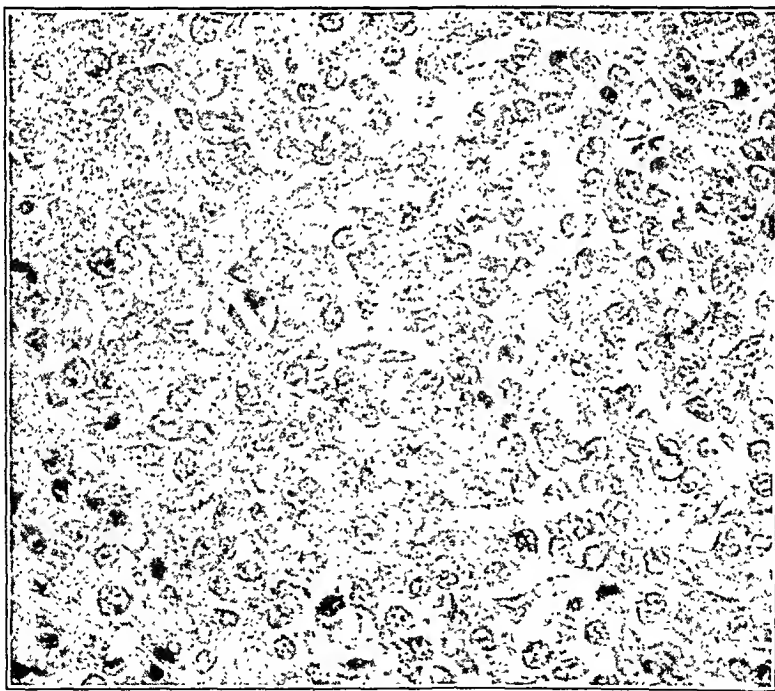


Fig. 6.—Photomicrograph of a section from the left side of the mandible showing large cells with vesicular nuclei; these resemble reticulum cells; moderate numbers of mitotic figures are evident ( $\times 600$ ).

evidence of spontaneous isoagglutination of the erythrocytes. The Wassermann and Kahn tests on the blood were negative throughout. The urea nitrogen content of the blood (Karr) was 112 mg. per hundred cubic centimeters. The total protein content of the blood was 6.24 per cent, albumin comprising 2.41 per cent, fibrinogen 0.65 per cent and globulin 3.18 per cent. Significant among the foregoing observations were the marked anemia, the marked retention of nitrogen and the reversal of the albumin-globulin ratio.

After another blood transfusion the patient began to improve generally; the maxilla was healing nicely, with no signs of recurrence visible. She was eating quite well and sitting up in a chair and asked to go home. On April 20 I was amazed to notice a small tumor on the lower left jaw, which I removed by diathermy two days later. Microscopic examination (fig. 6) showed the same type of plasma cell tumor.

The patient then became restless and demanded to go home. Two weeks later her physician reported that she had died suddenly. Unfortunately permission for autopsy was not granted.

The clinical picture, as in this patient, might easily be mistaken for that of a simple abscess of the gum or of an epulis (multinucleated cell tumor of the gum). Sachs and Garbe<sup>3</sup> described the latter condition, which is readily diagnosed by microscopic examination of the tumor.

#### SUMMARY

1. A case of myeloma originating about the alveolar process is reported.

2. It is suggested that instillations of iodized poppyseed oil into the antrum are best made through the natural ostium or by the Proetz displacement method, especially when a tumor involving the lower half of the antrum is suspected.

3. Early use of radium or roentgen therapy after radical removal of the tumor is advised.

The photomicrographs were copied from some furnished by the United States Army Medical Museum.

Dr. Edward Fendrick, of the East Orange General Hospital, helped with the pathologic description and the comments on the illustrations.

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3. Sachs, W., and Garbe, W.: Multinucleated (Giant) Cell Tumor of the Gum (Epulis), *Arch. Dermat. & Syph.* 38:603 (Oct.) 1938.

# PRIMARY CARCINOMA OF THE TRACHEA

ISIDORE MILLER, M.D., NEW YORK

Primary carcinoma of the trachea is a rare lesion; only 147 cases had been reported in the literature up to June 1936. This lesion forms 34 per cent of the primary tracheal tumors reported. The incidence of primary tracheal carcinoma in series of autopsies varies from zero to 1.4 per cent. The latter percentage was reported by Fraenkel.<sup>1</sup> Many hospitals have not noted a single lesion of this type in thousands of autopsies. Culp<sup>2</sup> reported that a personal survey yielded no primary carcinoma of the trachea observed in 15,000 autopsies at the Johns Hopkins Hospital; none in 7,000 autopsies at the Baltimore City Hospitals and none in 3,900 autopsies at the New Haven Hospital. He reported 2 cases; in 1 the lesion was the only primary tracheal carcinoma seen in 9,000 autopsies at the Pathologic Institute of McGill University, and in the other it was the only one noted in 12,700 autopsies at the Montreal General Hospital.

Karsner<sup>3</sup> stated that tumors of the trachea are uncommon; of the malignant tumors, which also are extremely rare, carcinoma is the most frequent, appearing usually as squamous epithelioma, probably originating in islands of squamous epithelium either of congenital origin or as the result of metaplasia following injury. Secondary tumors sometimes occur but are decidedly unusual. Figi,<sup>4</sup> on the other hand, found that adenocarcinoma is most common.

## REPORT OF A CASE

A 65 year old white man was admitted to the Farm Colony Hospital on Sept. 2, 1937. He had been in another hospital from August 6 to September 2 with the diagnosis of fractured right seventh rib and traumatic hemothorax. A roentgenogram of the chest showed emphysema and fracture of the right seventh rib. The chest was strapped, and when the symptoms cleared up the patient was transferred to the Farm Colony for further convalescence. On his admission to this institution his chief complaints were dryness and tickling of the throat. His past history included a history of a chancre forty years previously, which had never been treated, and several attacks of gonorrhea. He had been attending an outpatient clinic because of arthritis of the knees. His physical examination yielded essentially

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From the New York City Farm Colony and the Department of Pathology, Sea View Hospital, Dr. Oscar Auerbach, pathologist.

1. Fraenkel, E.: Ueber Luftröhrenkrebs, *Deutsches Arch. f. klin. Med.* **135**: 184 (Feb.) 1921.

2. Culp, O. S.: Primary Carcinoma of the Trachea, *J. Thoracic Surg.* **7**:471 (June) 1938.

3. Karsner, H. T.: *Human Pathology*, Philadelphia, J. B. Lippincott Company, 1926.

4. Figi, F. A.: Primary Carcinoma of Trachea, *Arch. Otolaryng.* **12**:446 (Oct.) 1930.



negative observations except that the lungs showed evidence of emphysema. Because of the presence of hoarseness, a laryngeal examination was made on September 21. Paralysis of the right vocal cord with absence of abduction was found. Syphilis was considered a possible etiologic agent because of the patient's history, but the Wassermann test was negative. A roentgenographic examination of the chest on October 26 showed generalized opacity involving the apex of the right lung and the infraclavicular region and an area of opacity in the apex of the left lung. The generalized opacity seemed to fill the entire superior aperture of the chest (fig. 1 *A*). The trachea was displaced to the left. The possible diagnoses were considered to be (1) enlargement of the thyroid, (2) a bronchogenic neoplasm in the upper lobe of the lung, (3) a tuberculous end stage caseous pneumonic lesion and (4) aneurysm of the aorta. Fluoroscopic examination showed the mass to be distinct from the aorta. A roentgenogram of the chest one month later disclosed a metastatic nodule in the lower lobe of the right lung (fig. 1 *B*).

Bronchoscopic and esophagoscopy examination were done on December 28 by Dr. A. Seligman. At a point in the trachea, 20 cm. from the tooth line, a bleeding



Fig. 1.—*A*, roentgenogram taken on Oct. 26, 1937, showing an opacity filling the entire superior aperture of the chest and an area of opacity in the apex of the left lung. *B*, roentgenogram taken on Nov. 17, 1937, showing a metastatic nodule in the lower lobe of the right lung.

mass was found, from which a specimen was taken for biopsy. The posterior wall of the trachea bulged. The esophagus showed some compression. The biopsy was performed by Dr. Auerbach, who reported that "Microscopic examination reveals large sheets of epithelial cells. The nuclei are hyperchromatic, large and oval or round. Numerous mitotic figures are present. The diagnosis is squamous cell carcinoma."

The patient felt better for two days after the bronchoscopic examination. He was elated that his hoarseness had decreased. But this was only temporary. Dyspnea and cyanosis increased, and the patient died on Feb. 13, 1938.

The necropsy was performed by Drs. Auerbach and M. Herman. On opening the thoracic cage, a large mass was noted extending up from the bronchial bifurcation to the fifth cervical vertebra on the right side of the vertebral column. This mass measured 15 cm. in its vertical direction and 9 cm. in its greatest transverse direction. It was composed of matted firm lymph nodes, which on section revealed

a whitish aspect. In the right angle was a fluctuant mass measuring 6 cm. in its vertical direction, which on section exuded about 2 ounces (60 cc.) of purulent material and large white particles. A great deal of coal pigment also was present. In the upper posterior aspect there was another fluctuant mass, which measured 6 cm. in its vertical direction. On section this revealed a small amount of purulent material and a pinkish substance which could be teased out into strands. The larger arterial vessels traversing this mass were markedly constricted, and the lumens were appreciably narrowed. The entire mass was firmly adherent to the trachea. Six centimeters from the inception of the esophagus in the pharynx were several firm, whitish masses measuring up to 2 cm., which surrounded that organ, causing some narrowing of the lumen. These masses on section presented a whitish, glairy aspect.

Four centimeters below the true vocal cords the trachea revealed a fungating mass, which extended down to the bifurcation, approximately 9 cm. This fungating mass had a cauliflower appearance and was pinkish. It was firmly adherent to the underlying mucosa and was soft. The distribution was principally on the anterior and right lateral surfaces.

The upper lobe of the left lung presented posteriorly beneath the thickened pleura at the apex an area 2 cm. in the apicobasal direction and 1.5 cm. in the mediolateral direction. This was flat topped and firm to the touch. This focus was not sharply demarcated from the surrounding lung tissue. In the anteromedial aspect, 8 cm. from the apex, just below the visceral pleura, was a firm, rounded nodule measuring 1 cm. On being sectioned this was flat topped, presented a whitish brown homogeneous appearance and was sharply demarcated from the surrounding lung tissue. In the lower lobe of the left lung, 8.5 cm. from the apex and just below the lateral pleura, was a nodule 1.5 cm. in its apicobasal direction and 1 cm. in its mediolateral direction. This was firm, flat topped and whitish pink and was sharply demarcated from the surrounding lung tissue. In the lower lobe of the right lung, anteriorly, was a large nodule 2 cm. in length and 3 cm. in width. On being cut it presented a whitish brown aspect and was sharply demarcated from the surrounding lung tissue (figs. 2 and 3).

In the upper third of the esophagus there was an ulcerated area, 3 cm. in circumference. The surrounding walls were elevated and overhanging. The base had a white surface and was clean. The entire area felt indurated.

The pathologic observations were as follows: carcinoma of the trachea with metastases to the lower lobe of the right and the upper and lower lobes of the left lung; localized fibrous pericarditis; dilatation of the left ventricle; calcification of the aortic valve; atheromatosis of the coronary vessels; atheromatosis, calcification and ulceration of the aorta; dilatation of the ascending aorta; calcification of the capsule of the spleen; perisplenitis; congestion of the liver, spleen and kidneys; retention cyst of the kidney; bilateral granular kidney; diverticulosis of the large intestine; ulceration of the esophagus; healed old fracture of a rib; mediastinal tumor—(1) suppurative paratracheal lymphadenitis and (2) metastatic lymph nodes (carcinoma); benign hypertrophy and adenoma of the prostate.

Histologic examination of the trachea was reported on as follows: In one area the epithelial lining is columnar. It is interrupted, and in the region involved are dense nests of epithelial cells arranged in sheets. These sheets of epithelial cells extend into the periglandular region, encircle the cartilage and extend into the adventitia. In some regions these nests of epithelial cells are present beneath the intact epithelium. The nuclei of the cells are oval or round and are of various size. Most of the cells, however, are large. Mitotic figures are present also. Most of the nuclei are vesicular; some are hyperchromatic.

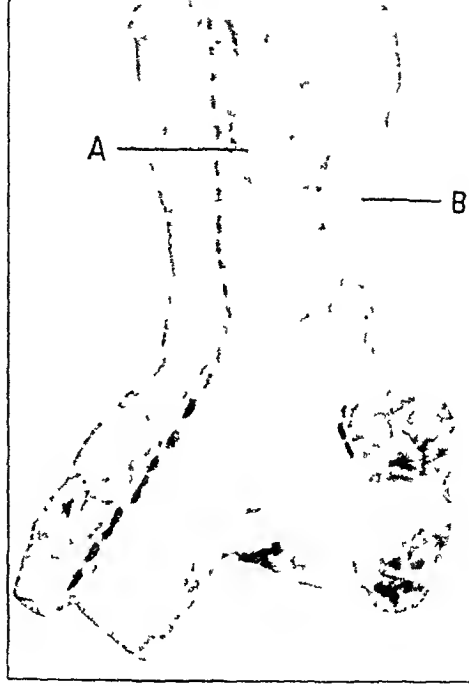


Fig. 2.—A section of the trachea and the main bronchi. The fungous carcinoma (*A*) is present along the entire course of the trachea. There is extensive infiltration of the carcinoma through the wall of the trachea (*B*).

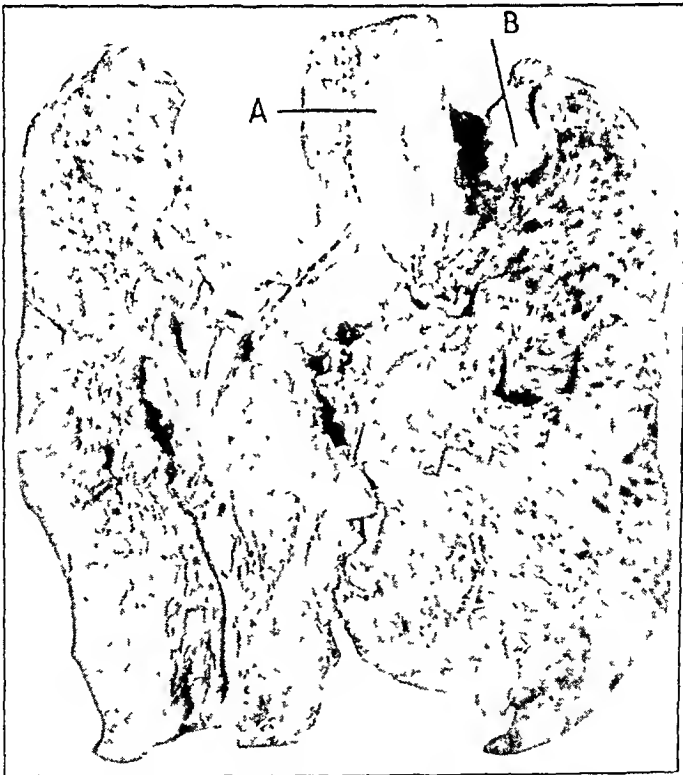


Fig. 3.—Coronal section of the lungs. The carcinoma of the trachea in figure 2 is seen in this view (*A*). Carcinoma has also extended into the upper portion of the upper lobe of the left lung (*B*).

## COMMENT

Primary carcinoma of the trachea is rare; however, the literature on the subject is fairly complete. Because of the rarity of the lesion, new cases are usually reported. The literature has been frequently reviewed and brought up to date.

The condition has been reported in every decade from the second to the ninth, with the largest incidence in the fifth and sixth decades. Males have predominated in the reported cases (6:4). Metastases were usually to the esophagus, the mediastinal, peribronchial and cervical lymph glands and the lungs. Tickling in the throat and hoarseness were common initial symptoms, but cough, hemoptysis, dyspnea and wheezing respiration were frequently present as the main symptoms. The prognosis is poor. The diagnosis is still seldom made ante mortem, but the more frequent use of laryngoscopic and bronchoscopic examinations will be of inestimable aid in the quicker recognition of tracheal tumors.

## SUMMARY AND CONCLUSIONS

A study of a case of primary carcinoma of the trachea in a 65 year old white man has been presented. A tickling sensation in the throat and hoarseness were the initial symptoms. Bronchoscopic examination was the most important method of diagnosis. Laryngoscopic and roentgenologic examinations also were an aid. The patient died six months after the symptoms first appeared. The more frequent use of bronchoscopic examination will enable more diagnoses of this disorder to be made ante mortem.

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# Clinical Notes; New Instruments and Technics

## A TUNING FORK AUDIOMETER

AARON ROTH, M.D., BROOKLYN

In 1932 I suggested a graphic method of tuning fork audiometry.<sup>1</sup> The method was tedious and not based on a standardized scale of normal hearing. It was abandoned.

In 1934 I devised the acoustimeter. This consisted of a series of calibrated tuning forks mounted on a revolving turret. The forks were struck by a swinging hammer allowed to drop from a constant level. A stop watch connected with the hammer indicated the duration of audibility (from the time the fork was struck to the loss of audibility). The number of seconds of audibility was marked in a corresponding place on the chart. This at once showed the loss of hearing in decibels.

In connection with this instrument the principles of modern audiometric arithmetic were for the first time applied to precision tests of acuity of hearing with tuning forks as the source of sound.

However, the instrument was cumbersome, expensive and difficult to standardize.<sup>2</sup>

### NEW PRECISION FORKS

I have now made a series of calibrated forks. A detachable hammer is provided. Together these constitute a practical, accurate, portable and inexpensive audiometer. The forks are light and are not mounted but held suspended on the examiner's fingers. There are no extraneous and confusing sounds. The method and chart are based on the standard scale of threshold of hearing to threshold of feeling used with electrical audiometers.

The application of the decibel (unit of intensity of sound) to tuning fork values is self explanatory on the chart.

It was necessary to make forks that could produce intensities loud enough to reach the upper level of the range of hearing (that is, the threshold of feeling).

In connection with the tuning forks there are several entirely new features which I have not published before.

Through the stem of the fork is a cross pin used as a rest on the thumb and finger (fig. 2). This makes the fork a freely suspended vibrating source of sound. By this method of suspending the fork the absorption of the vibrations into the hand is minimal and constant. This method of using the forks is an important factor in assuring constancy of the source of sound.

A significant new principle is seen in the cup-shaped sound collector which I have fashioned at the end of the stem. This conveys the sound clearly and

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1. Roth, A.: A Graphic Method and Chart for Hearing Test with Tuning Forks, Arch. Otolaryng. **15**:834 (June) 1932.

2. Roth, A.: The Acoustimeter: A Device of Tuning Forks with a Graphic System for Charting Acuity of Hearing, Arch. Otolaryng. **20**:571 (Oct.) 1934.

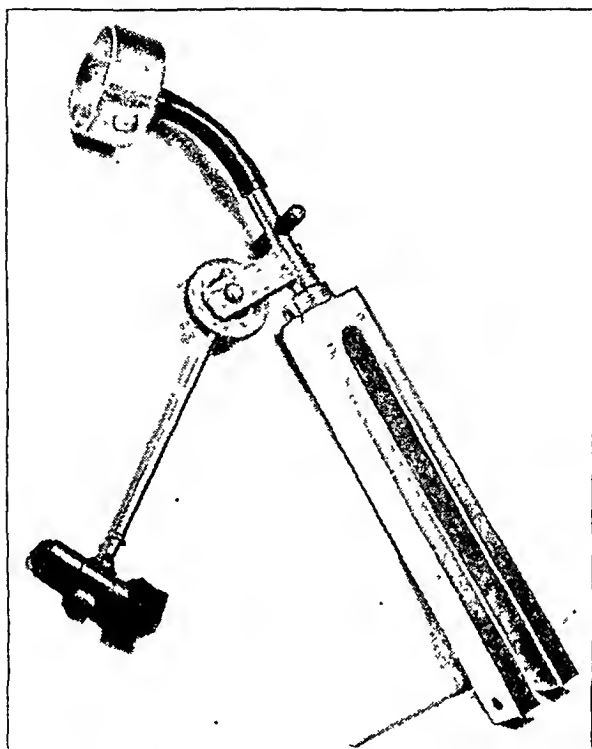


Fig. 1.—New precision fork with hammer in place.

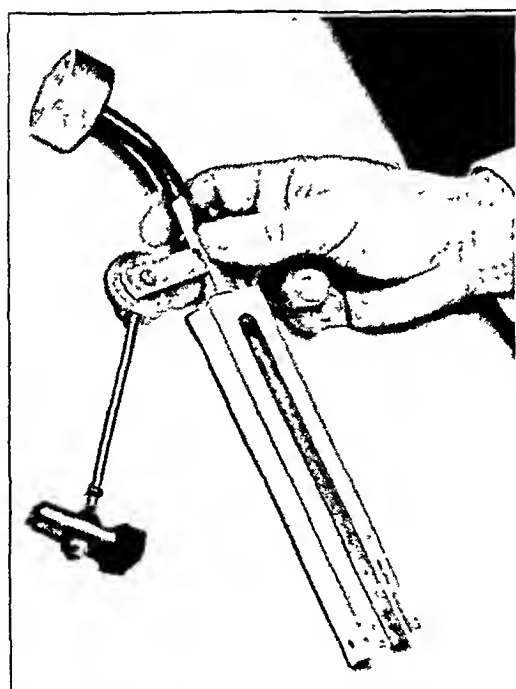


Fig. 2.—Fork with cross pin resting on the thumb and finger.

completely to the ear (fig. 3). By these features it is obvious how one attains constant intensities of the sound produced by a hammer dropped from a constant level.

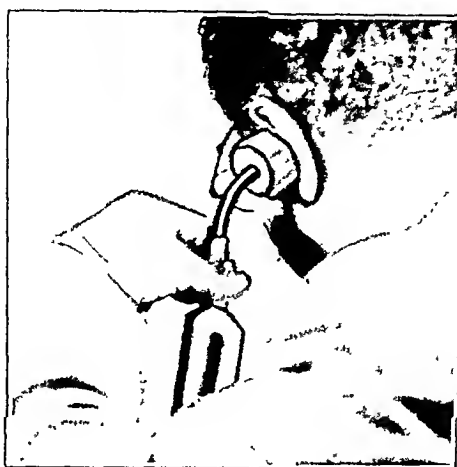


Fig. 3.—Sound collector in contact with the ear.

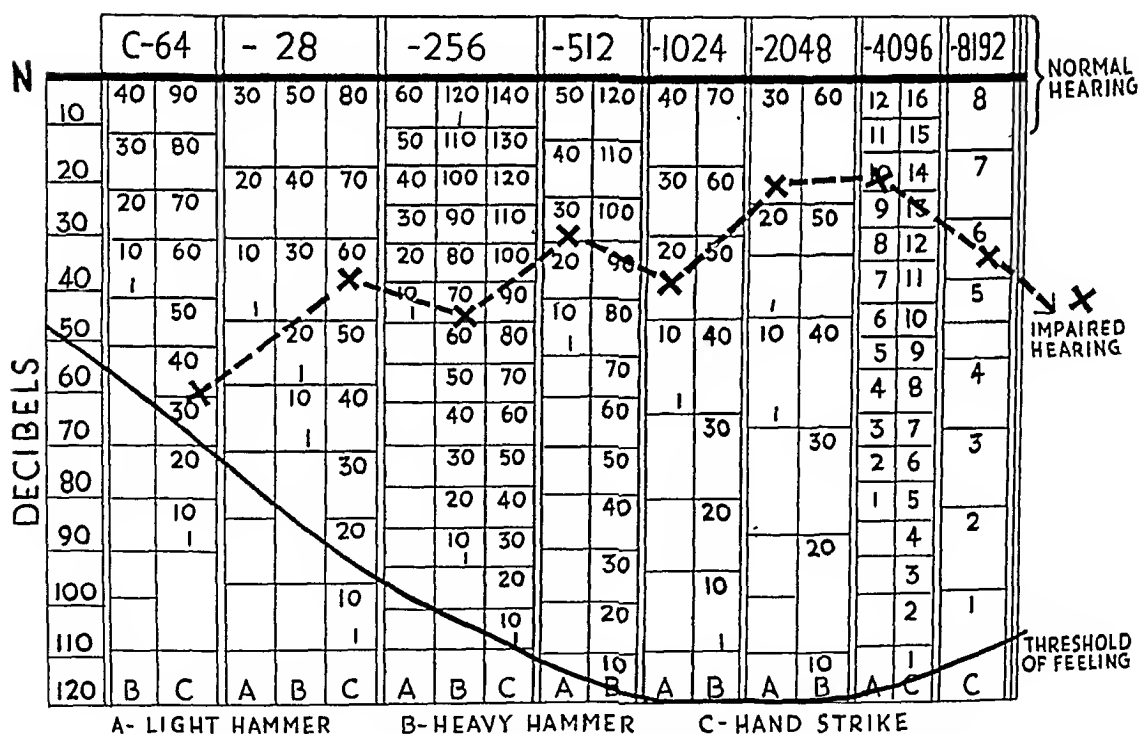


Fig. 4.—Curve of acuity of hearing charted by the method described.

In the stem of the fork is a slot for the insertion of the hammer. One hammer serves the whole series of forks. The hammer is detached after the strike.

In the clinical procedure of testing acuity of hearing the hammer is raised to a horizontal position and dropped. On the rebound it is caught and removed. The second hand of a clock is observed for the duration of audibility (from the instant

of the strike to the instant of loss of audibility in the ear examined). For the number of seconds so noted there is a corresponding space in the column of the chart. A mark is made in this space. The same procedure is followed with the whole series of forks and the marks connected in one continuous curve. The result is the curve of acuity of hearing.

*Explanation of the Chart.*—For each fork there are three columns, spaced at intervals of several seconds. The total column represents the interval from the instant of the strike to the point of loss of audibility for the normal ear. The first column is spaced for the use of a light hammer. The second column is spaced for the use of a heavy hammer. The third column is spaced for striking by hand with the heavy hammer, using fullest force. (In the last case the maximum intensity is always obtained. For it is characteristic of tuning forks that their maximum intensities are produced by a certain limit of striking force, beyond which an increase in the force of the strike cannot produce a greater intensity.)

Striking by hand is used only rarely and then in the examination of patients that obviously have an impairment near or on the borderline of total deafness.

The purpose of these three columns for the respective manner of striking is to save time in the examination. For moderate impairments the light hammer gives results quickly. If the patient hears nothing with the light hammer strike, then he is tested with the heavy hammer strike. In the average case less than ten minutes is required for the testing of both ears. In other respects the chart is self explanatory.

#### COMMENT

In my original experiments I calibrated the tuning forks by means of a sound level indicator which showed the maximum intensity of each fork and also the rate of decay per second in decibels. By these data combined with tests of normal ears the spaced columns as they appear in the chart were easily established. These forks, after being calibrated, can be used as the standard for calibrating electrical audiometers. Vice versa, also, an electrical audiometer can be the standard for calibrating the forks. The forks will remain constant in pitch and intensity potentials, there being no wearable and varying elements, such as are necessary in intricate electrical hook-ups. There is no bone conduction factor of error when the sound collector is in contact with the auricle. I have observed that the auricle and the soft canal act as practical insulation against bone conduction. It is a simple experiment to prove this assertion. The use of the sound collector proves this. A patient with increased bone conduction will show increased bone conduction by this method of examination the same as by the usual manner of fork testing (holding the prongs to the meatus for air transmission and pressing the stem of the fork on the mastoid for bone transmission).

#### SIMPLE INSTRUCTIONS TO ASSURE ACCURACY

The sound collector must be brought in light contact with or close to the ear every several seconds until the sound becomes very faint. Then and only then the collector is pressed firmly over the auricle, removed and pressed on again alternately until the sound is no longer perceived.

The experiments and application of the adduced data which have led to the present precision forks and charting method were tedious efforts in some respects in view of the utter lack of any guiding texts or literature on the subject. The peculiarities of the absorption and transmission of the vibrations of the forks (with the stem in contact or freely suspended) had to be personally discovered



without benefit of an environment of research, and so I shall hope to hear of other otologists with better opportunities for research making use of the data here contributed. In the meantime, in the interests of maintaining standard values of acuity, permission to manufacture these forks has been given to Clay Adams of New York, in association with the Acoustic Research Laboratories of New York.

## EASY LIGATION OF BLOOD VESSELS IN CONNECTION WITH TONSILLECTOMY

### A New Instrument and Method

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The control of bleeding which occurs during the surgical removal of tonsils is unquestionably an important part of the operation. The routine procedure

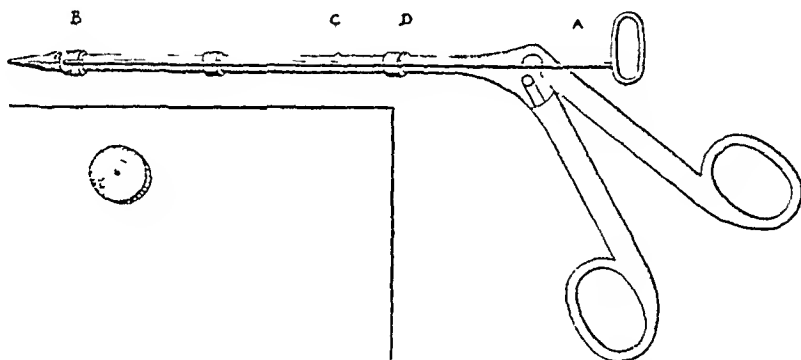


Fig. 1.—Forceps with sliding push ring, *B*, and push rod, *A*. *C* and *D* set the limit of sliding in both directions. Inset, elastic disk enlarged. The actual size is 5 mm. in diameter and 1.2 mm. in thickness.

consists in applying pressure to the tonsillar fossa by means of gauze sponges. In a large per cent of cases this suffices to control hemorrhage. The length of time over which pressure is to be applied is usually not less than three minutes but often considerably more. Unfortunately, even though cessation of bleeding may have been achieved, it is a matter of chance whether bleeding may occur again soon after operation or during early convalescence, if pressure alone is used. A child, especially, may lose considerable blood before the fact that he is bleeding is discovered.

Aside from pressure, the method most frequently used to control tonsillar hemorrhage is clamping of the bleeding points or the application of a catgut ligature around them. The application of a ligature is sometimes difficult, particularly when

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the source of the hemorrhage is the lower part of the tonsillar fossa. The ligature may become loosened and the bleeding be controlled only by suture.

Surgeons have long sought an efficient, quick method to stop hemorrhage during and following tonsillectomy. The instrument about to be described has been designed with this fact in view. It consists of a grasping forceps of the alligator jaw type (fig. 1). A small rubber disk which has a puncture hole in its center is slipped over the slender grasping end of the forceps (fig. 1, inset, and 2 *A*). This disk is very elastic and is 5 mm. in diameter and 1.2 mm. thick. It is applied to the

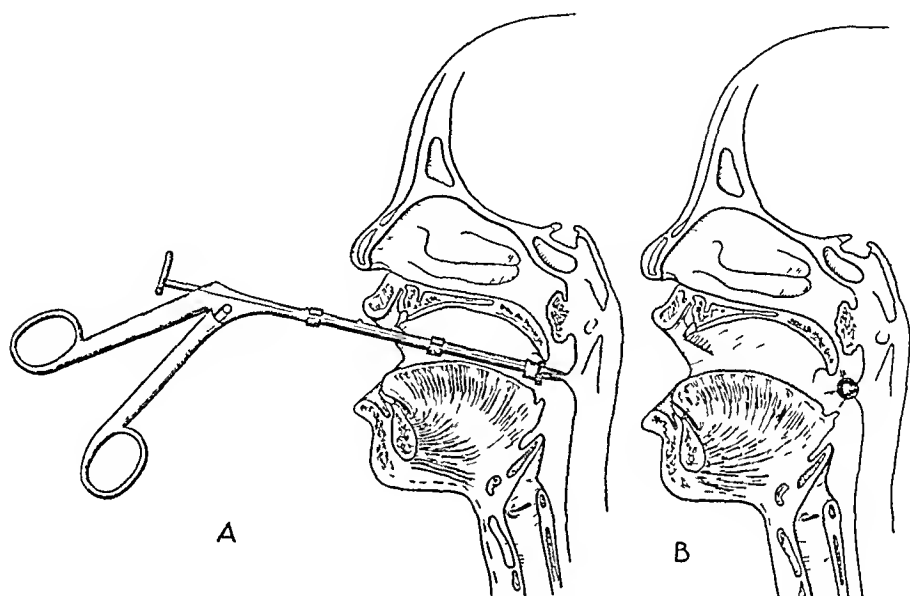


Fig. 2.—*A*, instrument ready to place a ligature. *B*, ligature in position. The rubber disk is presented somewhat enlarged. Note the tissue emerging through the center of the rubber disk.

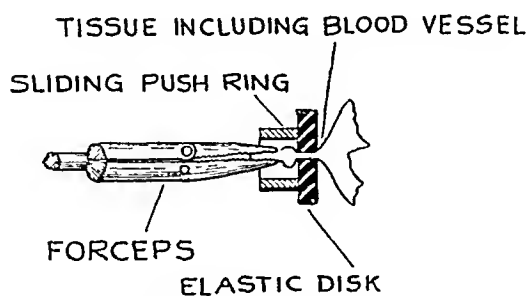


Fig. 3.—Enlarged details of ligation. Note the amount and length of tissue emerging through the center of the rubber disk.

bleeding point by pushing it downward over the end of the forceps by means of a rod which extends from the grasping tip to the handle.

The technic of the procedure is as follows: The bleeding point is seized with the forceps equipped with the rubber disk, and the disk is pushed over the end of the forceps to encircle the tissue held. The transfer of the rubber disk to the tissue is made by pushing the sliding ring downward (fig. 3).

It is an advantage to grasp a substantial portion of tissue with the hemostat. If properly applied (fig. 2 *B*), the elastic tie will remain in position several days.

For experimental purposes, I have left some in the tonsillar fossa as long as one week. Their presence causes no discomfort. They may readily be removed with a grasping forceps at the end of forty-eight hours.

By use of this instrument, all bleeding can be controlled and the time of operation considerably shortened.

Two or more complete instruments should be ready for use on the instrument tray during operation, and a liberal supply of rubber disks should be at hand.

The hemostat is sterilized by boiling; the rubber disks, by the use of alcohol.

Skill in the use of this instrument can readily be acquired by practice on a piece of tough meat.

106 East Eighty-Fifth Street.

# Progress in Otolaryngology

Summaries of the Bibliographic Material Available  
in the Field of Otolaryngology

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## ADVANCES IN THE FIELD OF ALLERGY AS RELATED TO OTOLARYNGOLOGY DURING THE YEAR 1939

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AND

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In the following annual review our aim has been to select a few articles which show the present trend of the literature on allergy. Some of the articles chosen present new ideas. Others repeat studies already reported and are referred to here because of a fundamental importance which should again be called to the attention of the readers.

### CAUSES OF ALLERGY

*Foods.*—Bowen<sup>1</sup> reports 5 cases of urticaria caused by the ingestion of karaya gum. This substance at present is used in many preparations prescribed for increasing the bulk of stools. It is used also in dental powders, tooth paste and in a number of gelatin preparations.

*Molds.*—Rackemann<sup>2</sup> reviewed the literature on the relation between molds and hay fever and asthma. He concludes that many atypical cases of hay fever may be accounted for by sensitivitiy to molds. The occurrence of molds in household dusts also accounts for the fact that asthma is often limited to certain environments. He calls attention to the difficulties in interpreting cutaneous tests with mold extract and suggests that the specificity of mold extracts may be important.

Durham<sup>3</sup> reports a study of the distribution of *Hormodendrum*, *Alternaria* and rust spores. This is a continuation of work previously reported. The data were obtained by a study of some 10,000 samples

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1. Bowen, R.: Karaya Gum as a Cause of Urticaria, Arch. Dermat. & Syph. **39**:506 (March) 1939.

2. Rackemann, F. M.: Molds as a Cause of Hay Fever and Asthma, Tr. Am. Climat. & Clin. A. **54**:194, 1939.

3. Durham, O. C.: Incidence of Air-Borne Fungus Spores: *Hormodendrum*, *Alternaria*, and Rust Spores, J. Allergy **10**:40, 1938.

of atmospheric dust caught on oil-coated slides exposed by United States weather observers over several years. He states that *Alternaria* and *Hormodendrum* spores are found in the air in greatly varying numbers in all parts of the United States. The total figures for the two are approached by no other air-borne fungus spores except those of the rusts and smuts. There is a striking similarity in the quantitative geographic distribution of *Alternaria* and *Hormodendrum*, not only as compared with each other but also as compared with ragweed. Where one is abundant the other two are likely to be abundant.

Harris <sup>4</sup> studied 13 patients allergic to grain dust. Each patient gave a positive intradermal reaction to extracts of wheat dust and oat dust and also reacted to one or more grain smuts. Reactions to grain dust and grain smut were transferred in every patient tested. Symptoms following exposure to grain dust were classified in two varieties: (1) irritative symptoms, which consisted of a burning sensation in the throat and chest and which occurred in both allergic and nonallergic persons, and (2) allergic symptoms, which included sneezing, itching of the eyes, wheezing and asthmatic paroxysms and which occurred in allergically disposed persons. In 4 out of 5 cases the author successfully produced an exacerbation of symptoms by applying cotton pledgets soaked in grain dust extract or smut extract to the inferior turbinate. He suggests a relation between sensitiveness to grain dust and that to grain smuts. A few patients were successfully treated by desensitization. Constitutional reactions were not uncommon during desensitization.

Wittich <sup>5</sup> confirmed an immunologic relation between smuts and their corresponding hosts, the grains.

Cohen, Cohen and Hawver,<sup>6</sup> continuing their study of house dust antigen in cotton linters, describe a "linters extract . . . with which immunologically specific endermal reactions may be obtained in dust-sensitive patients." Well over 90 per cent of clinically dust-sensitive patients gave a 1 plus or larger endermal reaction to a 1:50 dilution. Control experiments on normal persons and allergic persons not sensitive to dust gave negative results. They were able to sensitize and shock guinea pigs with linters extract.

*Chemicals.*—Kern <sup>7</sup> reports a case of asthma and allergic rhinitis due to sensitiveness to phthalic anhydride.

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4. Harris, L. H.: Allergy to Grain Dusts and Smuts, *J. Allergy* **10**:327, 1939; The Nature of the Grain Dust Antigen, *ibid.* **10**:433, 1939.

5. Wittich, F. W.: Further Observations on Allergy to Smuts, *Journal-Lancet* **59**:382, 1939.

6. Cohen, M. B.; Cohen, S., and Hawver, K.: Further Observations on the Nature of the House Dust Antigen, *J. Allergy* **10**:561, 1939.

7. Kern, R. A.: Asthma and Allergic Rhinitis Due to Sensitization to Phthalic Anhydride, *J. Allergy* **10**:164, 1939.

Phthalic anhydride is the anhydride of benzene-ortho-dicarboxylic acid (phthalic acid). It has the formula  $C_6H_4(CO)_2O$ , and is a benzene ring substance. . . . Phthalic anhydride is the starting point for the manufacture of fluorescein and anthraquinone dyes. With glycerol it reacts to form a resin that is used in the paint industry. . . . An unusual feature of the case is the demonstration of circulating specific reagin to a substance of non-nitrogenous nature.

Romanoff<sup>8</sup> reports 3 cases of bronchial asthma caused by exposure to sulfur dioxide fumes in men working about electric refrigerators. None of the patients had a personal or family history of allergy. He states:

. . . There is no immunologic proof of the specificity of sulfur dioxide fumes in initiating attacks of bronchial asthma. It appears more likely . . . that the primary effects are the result of an inflammatory, destructive lesion in the upper respiratory tract, [allowing bacteria to] . . . multiply and gain access to underlying tissue. . . . Sulfur dioxide refrigerants represent an industrial hazard, particularly for individuals with an allergic background.

*Miscellaneous Agents.*—Rowe<sup>9</sup> reports a case of bronchial asthma and nasal allergy with proved sensitivity to pine pollen. Hyposensitization with specific pine pollen extracts controlled the symptoms.

The late Parlato<sup>10</sup> reports an excellent study of the May fly. Allergic symptoms are believed to have been caused by the inhalation of minute particles of the pellicle. In his study of 589 patients with seasonal hay fever and asthma he found 19 who gave repeated positive cutaneous reactions to extract of the whole May fly. Of these, 7 patients, or a little over 1 per cent of the total, could be proved clinically hypersensitive to May fly. He feels that the May fly should take its place with the caddis fly as an excitant of allergic symptoms.

Kahn<sup>11</sup> reports a case of rhinitis due to amaranth pollen in which cutaneous and ophthalmic tests gave negative results but in which a positive reaction resulted from the direct application of the pollen to the turbinates. After a positive diagnosis had been made from intranasal applications of pollen, unilateral facial acne occurred on the same side. This lesion reappeared at the same site on four different occasions in the course of specific treatment.

Berger<sup>12</sup> reports a case of intermittent hydrarthrosis in which an allergic causation was established. Elimination of offending foods not

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8. Romanoff, A.: Sulfur Dioxide Poisoning as a Cause of Asthma, *J. Allergy* **10**:166, 1939.

9. Rowe, A. H.: Pine Pollen Allergy, *J. Allergy* **10**:377, 1939.

10. Parlato, S. J.: The May Fly as an Exciting Cause of Seasonal Allergic Coryza and Asthma, *J. Allergy* **10**:56, 1938.

11. Kahn, I. S.: Sensitization of Skin Induced by Turbinal Pollen Application, Resulting in Facial Acne, *J. Allergy* **10**:235, 1939.

12. Berger, H.: Intermittent Hydrarthrosis with Allergic Basis, *J. A. M. A.* **112**:2402 (June 10) 1939.

only caused the disappearance of the swelling of the knee but also relieved gastrointestinal symptoms and vasomotor rhinitis.

Boemer <sup>13</sup> reports several cases to demonstrate an association between infection, arthritis and allergy. He thinks that the three conditions can occur together as a clinical entity. Allergic treatment is suggested.

Ross <sup>14</sup> reports a case of peripheral neuritis in an apiarist following stings by honeybees (*Apis mellifica*). He thinks the reaction is due to hypersensitivity to allergens in the bee.

Todd, Cohen and Broadbent <sup>15</sup> in a study of 60 children under treatment for allergy found that 75 per cent had gross orthodontic deformity. They explained this as follows:

In infancy growth is most rapid in the head. . . . More than half the post-natal growth in brain takes place during the first year. Facial growth is less rapid than this, but, since the face is an appendage of the brain case, it cannot fail to follow the cranium in an extraordinarily rapid growth.

All rapidly growing structures are vulnerable, and hence it comes about that facial growth is in greatest danger of mutilation during the first year. . . .

The face grows simultaneously in all three dimensions [and] . . . although the major defect may be shown in only one or two [all dimensions may be affected].

In . . . children who have nasal symptoms in early infancy the face will be markedly retarded in growth in all three dimensions. Those whose symptoms begin during the second year have less marked deformities, especially in the lateral expansion of the hard palate; in those whose symptoms begin at five or six years there may be only a slight diminution in either forward or downward growth.

Bourne <sup>16</sup> cites 2 cases in which asthma followed accidental injury to the nose. Neither patient had any allergic manifestation previously, and neither had a family history of allergy. The injuries had produced septal deformity. Complete disappearance of the asthmatic symptoms followed submucous resection. He suggested that nasal injury may be a factor in the causation of asthma.

#### MECHANISM OF ALLERGY

Stoesser and Cook <sup>17</sup> studied 12 patients with asthma which "had proved intractable under routine allergic management. Various pro-

13. Boemer, L. C.: Infection, Arthritis and Allergy, *Laryngoscope* **49**:297, 1939.

14. Ross, A. T.: Peripheral Neuritis: Allergy to Honeybee Stings, *J. Allergy* **10**:382, 1939.

15. Todd, T. W.; Cohen, M. B., and Broadbent, B. H.: The Role of Allergy in the Etiology of Orthodontic Deformity, *J. Allergy* **10**:246, 1939.

16. Bourne, W. A.: Asthma as a Sequel of Nasal Injury, *Brit. M. J.* **1**:870, 1939.

17. Stoesser, A. V., and Cook, M. M.: Electrolyte and Water Change in Bronchial Asthma, *J. Allergy* **11**:65, 1939.

cedures affecting the electrolyte and water metabolism" are reported on as follows:

1. Artificial fever gave . . . transitory benefit in asthmatics whose sodium chloride intake was normal or high before and during treatment.

2. Artificial fever gave striking improvement or complete remissions in asthmatics on continuous low salt diet. . . .

3. Remissions from the low salt intake plus artificial fever could be terminated promptly by adding 1 to 2 gm. of NaCl to the diet. . . .

4. Potassium chloride . . . [in large doses] when added to the special low salt diet [relieved] . . . asthma in milder cases. In more severe cases asthma continued while KCl was taken, but ceased at once when KCl was discontinued. . . .

The foregoing observations suggested that depletion of body water and salt . . . tended to favor remission of asthmatic symptoms. . . . It would appear . . . that sodium, potassium, and water metabolism bear an important relationship to the asthmatic state. It is suggested that drastic salt depletion favors a reduction of asthmatic symptoms. . . .

No positive therapeutic implications are [as yet] warranted.

Sheldon, Howes and Stuart<sup>18</sup> report a study on a relation between sodium and general body water and local tissue edema. Five patients were selected for study in whom attacks of asthma could be started or stopped when desired. They stated:

The asthmatic attacks of our subjects were associated with a considerable loss of body water and a distinct elevation in urinary sodium. The sodium depletion was directly related to the body water loss, as measured by the balance studies. . . .

The water metabolism directly paralleled that of the sodium. . . .

The loss of body fluid occurred in spite of a . . . [delay of water in] the shock organ. It would follow that a redistribution of fluid and electrolytes . . . takes place . . . [which is independent of the water] content of the shock organ tissues.

The possibility of "a new approach to the management of allergic disease through an understanding of water and sodium" movement is suggested.

Phillips<sup>19</sup> reports the study of a group of allergic persons who were exposed for the first time "to the pollen of sugar beet as the result of the introduction of a new industry into the region where they resided." In the second year of exposure a number of positive cutaneous tests were observed in patients who were not clinically sensitive to beet pollen. "In the third year skin tests were strongly positive, and intense symptoms of pollinosis occurred in a considerable number of the

18. Sheldon, J.; Howes, H., and Stuart, G.: Observations on Total Water and Sodium Exchanges in Asthmatic Patients, *J. Allergy* **11**:1, 1939.

19. Phillips, E. W.: Time Required for the Production of Hay Fever by a Newly Encountered Pollen, Sugar Beet, *J. Allergy* **11**:28, 1939.



patients." It seems from this series of cases that "two seasons of exposure to a newly encountered pollen were required to induce clinical sensitivity."

Watson and Kibler <sup>20</sup> present further evidence to support the idea that allergy can be an etiologic background for bronchiectasis.

A study of . . . 46 cases of bronchiectasis . . . reveals that a high percentage was found to have definite evidence of allergy based on the presence of hay fever, asthma, nasal polyps, atopic dermatitis, and abnormal amounts of eosinophiles in nasal or bronchial secretions. . . . Bronchiectasis . . . can be favorably influenced by allergic management. . . . The common association of sinusitis and bronchiectasis can be explained.

#### IMMUNOLOGIC STUDIES

Tuft, Wenger and Frankel <sup>21</sup> describe a method of preserving serum containing allergic antibodies or reagins, which they consider superior to that of Lichtenstein.<sup>22</sup> The principle of the method (previously described by Mudd and Flosdorf with their associates<sup>23</sup>) depends on a rapid freezing of the serum, followed by its rapid dehydration under high vacuum pressure. The resulting product is a porous solid in which reagins remain potent for months. The finished product dissolves quickly and completely in distilled water. This procedure is called lyophilization.

Cohen <sup>24</sup> has used this method, of lyophilization, in the preservation of pollen and dust extract. The desiccated material may be stored in rubber-capped bottles and redissolved in diluting fluid when needed for use. By this method, fresh, potent, accurately standardized extract can be made available at all times.

Langner and Kern <sup>25</sup> found that the "blocking or inhibiting antibody" of Cook can be preserved for eight months or more in lyophilized serum.

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20. Watson, S. H., and Kibler, C. S.: The Role of Allergy in Bronchiectasis, *J. Allergy* **10**:364, 1939.

21. Tuft, L.; Wenger, L. J., and Frankel, J. J.: Preservation of Reaginogenic Serum by Lyophilization, *J. Allergy* **10**:27, 1938.

22. Lichtenstein, M. R.: Preservation of Reagin in Dried Serum, *J. Allergy* **4**:239, 1933.

23. Mudd, S.; Reichel, J.; Flosdorf, E. W., and Eagle, H.: Preparation of Lyophile Serum, Proteins and Complement, *J. Immunol.* **26**:341, 1934. Flosdorf, E. W., and Mudd, S.: Procedure and Apparatus of Preservation in "Lyophile" Form of Serum and Other Biological Substances, *ibid.* **29**:389, 1935.

24. Cohen, M. B.: A Note on a New Method of Preserving Pollen and Dust Extracts, *J. Allergy* **10**:385, 1939.

25. Langner, P. H., Jr., and Kern, R. A.: Studies on Immunology of Hay Fever, *J. Allergy* **10**:1, 1938.

Bernstein, Rubin and Feinberg<sup>26</sup> studied the effect of antigen concentration on the rate of absorption of antigen solutions when injected. They concluded that "reactions are apt to occur more frequently and earlier when small concentrated volumes [of antigen] are injected."

Waldbott, Ascher and Rosenzweig<sup>27</sup> report serial studies of blood sugar, blood pressure, and white blood cell counts in 14 cases of allergic shock. They found that "a. The average blood sugar showed an immediate transient rise followed by a prolonged hypoglycemia. b. The blood pressure showed a sharp fall which varied [with the degree] . . . of shock. c. A definite leukopenia was encountered."

Hansel<sup>28</sup> emphasizes again

the value of the cytologic examination of the nasal, sinus and bronchial secretions as an adjunct in diagnosis and also as a guide in determining the clinical course of allergy of the upper and lower respiratory tracts . . . [particularly in] cases presenting secretory and vascular disturbances in the nose in which the symptoms are not typical of allergy. . . .

In the management of patients with respiratory allergy, an acute exacerbation of symptoms may be caused by an allergic contact or by an acute infection. Cytologic studies are of indispensable value in the differentiation of these two conditions. . . .

By . . . correlation of the allergic history and cytologic findings we have found that among children giving a history of frequent colds and bronchitis, there is a significant number who have nasal allergy.

#### TREATMENT

Keeney and his associates<sup>29</sup> suggest the use of epinephrine in oil in cases in which slow absorption of epinephrine is desirable. They give intramuscularly 2 mg. of epinephrine in 1 cc. of peanut oil and find that the hyperglycemic and cardiovascular response to it is prolonged. It is important to use dry sterilized syringes and needles to prevent contamination with water.

"Ten patients with chronic asthma who had been taking frequent daily injections or inhalations of epinephrine hydrochloride received [equal] relief . . . with 0.65 to 2 cc. doses of epinephrine in oil." The effect of one dose was inclined to last for from eight to sixteen

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26. Bernstein, T.; Rubin, S. S., and Feinberg, S. M.: The Effect of Volume of an Antigen Solution on Its Rate of Absorption, *J. Immunol.* **36**:309, 1939.

27. Waldbott, G. L.; Ascher, M. S., and Rosenzweig, S.: Serial Studies of Blood Sugar, Blood Pressure, and White Blood Cell Count in Allergic Shock, *J. Allergy* **10**:220, 1939.

28. Hansel, F. K.: Further Observations on the Cytology of the Nasal Secretions in Allergy, *J. Allergy* **10**:251, 1939.

29. Keeney, E. L.; Pierce, J. A., and Gay, L. N.: Epinephrine in Oil: A New Slowly Absorbed Epinephrine Preparation, *Arch. Int. Med.* **63**:119 (Jan.) 1939. Keeney, E. L.: Epinephrine in Oil: Its Effect in the Symptomatic Treatment of Hay Fever, *J. Allergy* **10**:590, 1939.

hours. For immediate relief, however, aqueous solutions proved superior. Prolonged relief followed the injection of epinephrine in oil in 30 of 35 patients with seasonal or perennial hay fever. The authors think that epinephrine in oil is a good symptomatic remedy, which can be used to advantage in combination with specific treatment. The possibility of sensitizing patients to some constituent of the oil must be kept in mind.

Murphy and Jones <sup>30</sup> report 9 cases of intractable asthma in which the number of injections of epinephrine required was remarkably reduced by the use of epinephrine in oil.

Cohn <sup>31</sup> reports 4 cases in which constitutional reactions followed the administration of epinephrine in peanut oil. The patients had "nausea, vomiting, chills, vesicular urticaria, cyanosis, increased dyspnea, and swelling and edema of the forearm." The use of peanut oil as a vehicle for epinephrine was questioned because of the possibility of an underlying hypersensitiveness to peanut oil.

Spain, Strauss and Fuchs <sup>32</sup> describe a new preparation of epinephrine which

by delaying the rate of absorption, lengthens the period of its influence upon the patient, thus lessening the frequency of administration. . . . [The medium used to retard absorption] is nontoxic, nonantigenic, reasonably stable, and can be easily self-administered. . . . The mixture to which epinephrine is added contains gelatin, sodium chloride, chlorobutanol, sodium bisulfite, glycerin, and water. Gelatin is chiefly responsible for the decreased rate of absorption of this mixture. . . . [A 1:500 epinephrine solution is used in contrast to the 1:1,000 aqueous solution. It was found, in a study of 50 patients with moderately severe or severe asthma] that an injection of 1 cc. of gelatin epinephrine twice daily would . . . control the asthmatic condition. In some instances doses of ordinary (aqueous) epinephrine would be required in addition, but the demands for this would be reduced from one to two doses for the twenty-four hours. . . .

The gelatin-epinephrine mixture . . . can easily be self-administered by subcutaneous injection, in contrast to the epinephrine in oil preparation of Keeney, which [should] . . . be given intramuscularly. . . . It is possible that the risks . . . with other therapeutic agents administered by injection might be minimized by the addition of gelatin. . . . Among such agents are diphtheritic, scarlatinal, and streptococcic toxoids, pollen extracts, and, particularly, horse serum preparations.

Bloom <sup>33</sup> reports 50 to 100 per cent relief obtained in 29 cases of hay fever by the use of potassium chloride. The rationale for the

30. Murphy, J. A., and Jones, C. A.: Slow Epinephrine in the Treatment of Chronic Asthma, *J. Allergy* **10**:215, 1939.

31. Cohn, J.: Unusual Reactions to Slow Epinephrine, *J. Allergy* **10**:459, 1939.

32. Spain, W. C.; Strauss, B. A., and Fuchs, A. M.: A Slowly Absorbed Gelatin-Epinephrine Mixture, *J. Allergy* **10**:209, 1939.

33. Bloom, B.: The Use of Potassium Salts in Hay Fever: Preliminary Report, *J. A. M. A.* **111**:2281 (Dec. 17) 1938.

use of this drug evolves about a theory that allergy is a disturbance of electrolyte metabolism. Pharmacologically, potassium chloride is similar to epinephrine in action, and it is suggested that the effect of epinephrine is due to potassium migration. The dosage prescribed was 5 grains (0.32 Gm.) of potassium chloride in water, administered three times daily.

Abt <sup>34</sup> reports striking results with oral administration of potassium chloride for children who have both hay fever and asthma. He noticed that the swelling and pallor of the nasal mucous membrane in allergic rhinitis disappeared in three to five days and that the discharge was decreased. He thinks that the action of potassium is to displace sodium in the tissues, thus producing local dehydration of the tissues.

Harley <sup>35</sup> states, "Oral potassium chloride therapy . . . [following the method outlined by Bloom], failed to produce a significant degree of improvement in a group of 43 allergic patients." This has been the experience of the reviewers.

Rusk and his associates <sup>36</sup> found elevation of the potassium content of the serum in patients suffering from asthma and urticaria. They feel that potassium metabolism is not yet clearly understood, but assume that most of the potassium in the body is stored in the tissues and that the blood acts as a transport medium. The administration of potassium chloride presumably replaces the depleted potassium content of the tissues. Patients treated with "high protein, low sodium, acid-ash diet with added potassium chloride" showed promising clinical results. In contrast to this, Cohen <sup>37</sup> found no benefit from the treatment suggested by Rusk. In 8 cases of chronic urticaria he obtained doubtful results.

Zeller <sup>38</sup> reviews the literature on oral therapy with ragweed pollen and presents a "clinical study of 42 cases of ragweed pollen hay fever treated by oral pollen administration." He doubts the advantage of oral therapy and found that treatment by hypodermic injection is distinctly better. He precipitated more reactions with oral therapy than with hypodermic injection.

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34. Abt, A.: Note on Oral Administration of Potassium Chloride in the Treatment of Hay Fever, Nasal Allergy, Asthma and Sinusitis, *Am. J. M. Sc.* **198**:222, 1939.

35. Harley, D.: Note on Oral Potassium Chloride Therapy in Asthma, Hay Fever, Urticaria and Eczema, *J. Allergy* **11**:38, 1939.

36. Rusk, H. A., and Kenamore, B. D.: Urticaria—New Therapeutic Approach, *Ann. Int. Med.* **11**:1838, 1938. Rusk, H. A.; Weichselbaum, T. E., and Somogyi, M.: Changes in Serum Potassium in Certain Allergic States, *J. A. M. A.* **112**: 2395 (June 10) 1939.

37. Cohen, A. E.: The Treatment of Chronic Urticaria with a High Protein, Low Sodium Acid-Ash Diet, with Added Potassium Chloride, *J. Allergy* **10**:61, 1938.

38. Zeller, M.: Oral Ragweed Pollen Therapy, *J. Allergy* **10**:579, 1939.

Black<sup>39</sup> concludes from his study that oral therapy with pollen is of value in some cases but that the results obtained are not nearly as satisfactory as with hypodermic administration of the antigen. In 3 of Black's patients tolerance for hypodermic doses developed after oral therapy.

London<sup>40</sup> states that little if any of the active principle of ragweed pollen is absorbed after its oral administration. He says, "Patients adequately treated by the subcutaneous method can expect no further benefit from oral ingestion of pollen."

Pollia<sup>41</sup> reports 3 cases of reaction after the oral administration of pollen. The symptoms were dermatitis, urticaria and aggravation of nasal symptoms.

Brown<sup>42</sup> reports beneficial results from the use of theophylline with ethylenediamine (aminophylline) in the treatment of status asthmaticus, or intractable asthma. He states, "Theophylline is also of value in the symptomatic treatment of mild or moderately severe attacks of bronchial asthma."

Meyer and Schotz<sup>43</sup> relieved severe intractable asthma by the use of cyclopropane anesthesia.

Farmer<sup>44</sup> inhibited fatal anaphylaxis in sensitized guinea pigs by the use of ethyl carbamate. On the basis of this experiment, he administered ethyl carbamate orally in 30 cases of bronchial asthma. A dose of 2 to 4 grains (0.13 to 0.26 Gm.) daily seemed beneficial in 14 cases.

Maytum and Leddy<sup>45</sup> report on roentgen therapy in 161 patients with moderately severe asthma. An anterior and posterior field over the mediastinum were irradiated. They suggest that the beneficial effects of roentgen therapy may be because "the roentgen rays decrease the secretory power of the mucous glands in the trachea [and] liberate antibodies by destruction of leucocytes." Another factor may be "the analgesic effect of roentgen rays on the nervous system." Twenty-four per cent of their patients were markedly relieved and 16 per cent

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39. Black, J. H.: The Oral Administration of Ragweed Pollen, *J. Allergy* **10**: 156, 1939.

40. London, McK.: Combined Oral and Subcutaneous Treatment for Ragweed Pollinosis, *J. Allergy* **10**:453, 1939.

41. Pollia, J. A.: Dermatitis, Urticaria and Aggravation of Nose Symptoms from Oral Administration of Pollen Suspensions, *California & West. Med.* **50**:25, 1939.

42. Brown, G. T.: Aminophyllin in Asthma, *J. Allergy* **10**:64, 1938.

43. Meyer, N. E., and Schotz, S.: The Relief of Severe Intractable Bronchial Asthma with Cyclopropane Anesthesia, *J. Allergy* **10**:239, 1939.

44. Farmer, L.: The Use of Urethane in Symptomatic Treatment of Bronchial Asthma, *J. Lab. & Clin. Med.* **24**:453, 1939.

45. Maytum, C. K., and Leddy, E. T.: Roentgen Treatment of Asthma, *J. Allergy* **10**:135, 1939.

moderately relieved for from one to several months. Fourteen per cent showed marked relief when roentgen and other types of therapy were used. For 46 per cent the results were failures.

Leriche and Fontaine <sup>46</sup> report on the result in 11 cases of bronchial asthma treated by stellectomy. The operation was either unilateral or bilateral. In about 50 per cent of the cases good results were obtained. They suggest that infiltration of the stellate ganglion with an anesthetic may be done in an effort to predict the result which might be obtained by stellectomy. This must be considered for the present a rather radical experimental measure.

Vollmer <sup>47</sup> treated 7 asthmatic children by insulin shock. He states that all were benefited, at least temporarily. Fifteen to twenty-five treatments were given over one and a half to three months. Doses as high as 40 units of insulin were given. The hypoglycemic reaction was carefully controlled by the use of dextrose. The "effect is ascribed to a secondary endogenous adrenalin production" in the patient and a possible "compensatory hyperfunction of the adrenal system."

Prince and Secrest <sup>48</sup> succeeded in protecting persons sensitive to bee, wasp or ant bites by hyposensitizing them with whole bee extract. They believe that certain insect groups possess a common antigen.

Piness and Miller <sup>49</sup> report that in 43 per cent of a large group of asthmatic children, tonsillectomy had been advised by a physician for the relief of asthma. Not only does this procedure fail to relieve asthma, but in 17 per cent of allergic tonsillectomized children it seemed actually to have initiated the asthmatic state and in many more to have aggravated mild symptoms. It is pointed out that the obvious cause of this unfortunate state of affairs is that allergic symptoms were mistaken for infectious symptoms and that the tonsils were thought to share in the infection. One of the distinct features of allergy is hyperplasia of the lymphoid tissue and as a result enlarged tonsils are characteristic findings.

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46. Leriche, R., and Fontaine, R.: Les résultats éloignés du traitement chirurgical de l'asthme bronchique par la stellectomie, *Presse méd.* **47**:243, 1939.

47. Vollmer, H.: Controlled Insulin Shock Treatment of Asthmatic Children, *Arch. Pediat.* **56**:223, 1939.

48. Prince, H. E., and Secrest, P. G., Jr.: Use of Whole Bee Extract in Sensitization to Bees, Wasps and Ants, *J. Allergy* **10**:379, 1939.

49. Piness, G., and Miller, H.: Allergy of the Upper Respiratory Tract in Infancy and Childhood, *J. A. M. A.* **113**:734 (Aug. 26) 1939.

# Abstracts from Current Literature

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## Ear

BRAIN HERNIA: A POSTOPERATIVE COMPLICATION IN OTOTOLOGY. COLBY HALL, *Ann. Otol., Rhin. & Laryng.* **49**:291 (June) 1939.

"Brain hernia" is herniation of the substance of the meninges and the brain through a defect in the dura and into a mastoidectomy wound. Hernias are divided into (1) immediate hernias, which occur immediately on incision of the dura, and (2) secondary hernias, which are postoperative. For hernia of the brain to occur there must be an opening in the bone, an opening in the dura and an increase in intracranial pressure. The increase in intracranial pressure is due to an increase in the volume of the brain produced by an abscess or tumor or by edema of the brain due to infection or irritation and not by increased formation of spinal fluid. A small dural defect does not preclude the formation of a large hernia of the brain. A small dural opening is more apt to produce strangulation of the hernia, and there is more likelihood of hernias which develop through a larger opening subsiding. The hernia may contain brain tissue alone, clean or infected, or pus from the main abscess, and a hernia of the temporal lobe may contain a prolongation of the lateral ventricle. In most strangulated hernias the tissue degenerates, finally becoming cicatricial, and eventually is covered with normal skin. All or most of the mass of a nonstrangulated hernia recedes into the cranial cavity and is epithelialized.

Immediate hernias usually disappear after evacuation of the abscess. Secondary hernias occur from within several days to several weeks postoperatively, first appearing as a soft granular mass. This becomes larger as it protrudes and is elastic and irreducible; it is reddish with no signs of necrosis.

There appears to be less danger of hernia if exploration for a possible abscess of the brain is done through a clean field, unless a discharging sinus is present. Protecting adhesions about a dural opening should not be disturbed, and all possible trauma should be avoided.

Early treatment should stress avoidance of trauma, prevention of infection and lowering of intracranial pressure. Lumbar punctures should be done with extreme caution, and intravenous administration of hypertonic solutions, such as 50 per cent dextrose, is more rational.

The author concludes that hernia of the brain in operations on the mastoid is usually avoidable and that the prognosis is dependent on the coexisting pathologic condition and the methods of treatment. He reports a case with recovery.

M. V. MILLER, Philadelphia.

DISCUSSION ON MALIGNANT DISEASE OF THE EAR (EXCLUDING THE PINNA).  
*Proc. Roy. Soc. Med.* **32**:1087 (July) 1939.

Mr. Philip Scott based his discussion on an analysis of 70 cases of malignant disease of the ear, of which 12 had not been previously published. He cited statistics tending to show that malignant disease of the ear, excluding the pinna, is rather rare. Among the factors which may arouse suspicion of malignancy are: (1) toughness of granulations when touched with a probe, (2) recurrence after removal and tendency to bleed easily, (3) persistence of meatal infection in spite of cleansing treatment, (4) pain on chewing and (5) presence of granulations or papillomas attached to the deep meatal wall.

Concerning the pathologic picture Scott stated that malignant disease of the ear is divided into four groups: (1) carcinoma, (2) sarcoma, (3) rodent ulcer and

(4) endothelioma. Carcinoma, by far the commonest type, may be primary or secondary, is nearly always squamous cell and starts in the external auditory meatus in the majority of instances. The sarcomatous type causes primary ulceration in the meatus and does not involve the tympanum until late. The rodent ulcer grows more slowly and recurs persistently. The treatment recommended consists of meatal operation when there is apparently no involvement of the drum and radical mastoid and meatal operation when the lesion has involved the drum or middle ear. Both types of operation are followed by diathermy or radiotherapy. Detailed reports of 5 cases of malignant disease of the ear were presented by Mr. Scott.

Mr. Lionel Colledge, in discussing carcinoma of the middle ear, emphasized the rarity of the condition and mentioned that occasionally it occurs as a secondary growth. He cited 2 cases in some detail.

Mr. Musgrave Woodman briefly reviewed the results obtained by treatment in 7 cases. Three patients were alive and free from recurrence.

Mr. F. C. Ormerod, Mr. McCay, Mr. Sydney Scott, Mr. Herbert Tilley and others cited interesting features of cases with which they had come in contact.

CAMPBELL, Philadelphia.

A STUDY OF VESTIBULAR PHYSIOLOGY AND PHYSIOPATHOLOGY. K. ARSLAN, Arch. ital. di otol. **51**:258 (May) 1939.

The application in hundreds of cases of the turning test according to the Buys-Fischer technic has shown the constant lack of the well known phenomena of nausea, vomiting, pallor, sweating and salivation following the tests. Since the sensation of rotation, nystagmus and tonic reflexes appeared with more precise and higher values than when other, less exact, tests were used, the deduction is warranted that the former phenomena are caused by a repercussion on the vegetative nuclei of irregular vestibular stimuli, either at the level of the cortical vestibular centers or at the site of the vestibular nuclei. These clinical observations were fully confirmed by Cojazzi in a series of researches on a group of normal persons, examined with the Buys-Fischer technic with a negative angular acceleration of standard value (630 degrees and 2 seconds). He also registered arterial pressure, frequency of the pulse and respiratory rhythm. Thereafter, Arslan conducted experiments with a more sensitive control on 50 rabbits, investigating the hemodynamic reflexes from vestibular stimulation by rotation on the turning chair of Fischer-Tönnies. All known precautions were taken to obviate other extralabyrinthine stimuli. The appearance of perrotatory and postrotatory nystagmus was noted; arterial pressure was registered on a kymograph affixed to the chair. Narcotics (ethyl carbamate [urethane] and ether) were administered to one group. The results of the experiment were that in most of the animals no change in the curve of the arterial pressure was noted. When modifications of the hemodynamic curve appeared, it was almost always possible to attribute them to extravestibular factors.

It is assumed that vestibulovegetative reflexes from labyrinthine stimulation are connected with irregular types of excitation, which cause diffusion of the excitation from the vestibular nuclei to the bulbar vegetative nuclei.

DENNIS, San Diego, Calif.

THE SYNDROME OF GRADENIGO DUE TO AN UNUSUAL CAUSE. G. ZANZUCCHI, Arch. ital. di otol. **51**:323 (June) 1939.

A case of exenteration of the mastoid cells on the right side in a woman aged 41, who had had chronic otorrhoea since childhood, is reported. A few days after the operation the patient began to have pain in the forehead and the right parietal region, extending to the occiput. Lumbar puncture was followed by paralysis of the right external rectus muscle, vomiting and severe headache. The paralysis lasted a few days.



The pain in the head was attributed to a focus of osteitis in the petrous tip that irritated the gasserian ganglion. The paralysis of the abducens nerve was attributed to lowered intracranial pressure from the spinal puncture, which caused hyperemia and consequent compression of the nerve.

DENNIS, San Diego, Calif.

ISOLATED DISEASE OF THE OTOLITHIC APPARATUS. L. ABBATE, Arch. ital. di otol. **51:341** (July) 1939.

After reviewing the functions of the otolithic apparatus and discussing the contradictory opinions of various writers, Abbate assumes that any movement whatever, whether pressure or traction, of the otolithic membrane is capable of exciting the sensory epithelium of the maculas. In man, excitation of the otolithic apparatus in pathologic conditions provokes nystagmus. In 1921 Bárány described a case of isolated disease of the otolithic apparatus characterized by vertigo and nystagmus in a certain definite position of the head which continued as long as the head was retained in that position. Abbate here reports illustrative cases, in which the condition was characterized by nystagmus and vertigo when the head was in a given position and at no other time but in which the reflex was quickly exhausted, lasting only eighteen to twenty seconds. The short duration is ascribed to the lightness of the disease and to the fact that it was retrogressing. The fact that the disturbance did not begin until the head arrived at the optimum position for stimulation of the otolithic apparatus shows that a maximum stimulus was necessary to evoke the almost latent irritation. The hyperexcitability of the labyrinth in the first case was indicated by the short time of latency in the caloric test. The use of some apparatus for the attaining of the desired position of the head without bending the neck is advised.

DENNIS, San Diego, Calif.

SPONTANEOUS HEMORRHAGE FROM THE CAROTID ARTERY IN ACUTE SUPPURATIVE OTITIS MEDIA. E. URBANTSCHITSCH, Monatschr. f. Ohrenh. **73:390** (June) 1939.

A case in which acute otitis media with mastoiditis developed in an adult after scarlet fever, with fatal erosion of the internal carotid artery, is reported. As a rule, such erosion occurs in chronic conditions, such as cholesteatoma and tuberculosis, but in this instance the necrosing scarlatina anginosa, ascending through the eustachian tube, may have destroyed the bony wall and eroded the artery, thus causing the bleeding. Most likely, the bodily resistance was diminished, too, through a diabetic state. Clinically, the patient did not exhibit any signs of severe peritubular infection.

LEDERER, Chicago.

CHRONIC SUPPURATION OF THE MIDDLE EAR AND VITAMIN C. M. BAER, Monatschr. f. Ohrenh. **73:394** (June) 1939.

The difference between the findings of the author and Chimani's results may be due to the variation in the living conditions of the populations examined. The author believes that the average Swiss population is better fed than are the populations whom he examined, who had nutritional deficiencies resulting from the war. Furthermore, experiments based on the influence of vitamin C on otitis media should not be discouraged by these differences of opinion.

LEDERER, Chicago.

THE CAROTID CANAL AND ITS CONTENTS IN RELATION TO SUPPURATION OF THE TIP CELLS OF THE PETROUS PYRAMID AND THE SURGICAL MANAGEMENT. ROBERTO PODESTA, Pract. oto-rhino-laryng. **2:133** (July) 1939.

The author has shown that the petrosal portion of the carotid artery loses the elastic fibers of the tunica media and so is differentiated from the cervical portion.

Yet there is no appreciable difference in the thickness of the wall of the vessel. He is one of the advocates for the belief that the space between the adventitia and the bony wall of the canal is filled by the plexus venosus pericarotidis and the sympathetic nerve structure. He states that when this periadventitial space is markedly developed the carotid artery is placed farther from the bony wall of the canal and that the reverse also is true. The size of this space is an important factor in any surgical procedure about the petrous tip, particularly in Ramadier's operation for petrositis. Its variability should not be underestimated, for it may present a serious danger. This space being borne in mind in cases of suppuration of the petrous tip, in which the periadventitial space has been penetrated by pus (as can be evidenced by the Horner syndrome), Ramadier's technic of evacuation and drainage is important.

An apical abscess can produce changes in the arterial wall, especially in the adventitia. The author has cited a case in which a mass of thickened granulation tissue extended from the arterial wall directly to the apical abscess. The bony wall of the canal was resorbed, so that the vascular nervous contents of the periadventitial space were in direct communication with the apical abscess. The author is of the opinion that this was one method by which thrombosis of the carotid plexus can occur, and, by extension, produce thrombosis of the cavernous sinus. This also may leave an easy avenue for laceration of the canal in the course of a surgical operation. When the artery is placed rather deeply within the bony wall of the canal and the thickness of the periadventitia is increased, the danger of an injury in the course of an operation is lessened. The plexus venosus pericarotidis shows marked variation in size in different patients. The author has presented sections which show that there is marked variation in the thickness in the periadventitial space, which becomes wider as the artery approaches the petrous apex and still wider in the vicinity of the cavernous sinus.

He concludes his discussion by emphasizing the relative importance of this space in Ramadier's operation.

PERSKY, Philadelphia.

OTITIS MEDIA IN TWINS. YUHEI NISHIURA, *Ztschr. f. oto-rhino-laryng.* **45**:718 (July) 1939.

The author reports his observation on 3 pairs of identical twin brothers, aged 3 months, 8 years and 15 years, and 1 of a pair of dissimilar sisters, aged 12 years, in whom acute otitis media developed.

In the 3 pairs of identical twins the onset, the progress, the amount and character of otorrhea and the roentgen observations on the mastoids were identical, though the appearance of the tympanic membranes was different during the course of the disease.

In the dissimilar twin sisters, aged 12 years, both mastoids were underdeveloped. Otitis media developed in only 1 sister, two weeks after an acute cold. The patient had numerous attacks of otitis media, while her twin sister was perfectly free from aural infection.

The author also conducted a comparative study on the nose, paranasal sinuses, teeth and larynx in the identical twins and found them similar.

HARA, Los Angeles.

## Pharynx

DYSKERATOSIS OF DARIER, OF EXCLUSIVE ORAL LOCALIZATION. L. ABBATE, *Arch. ital. di otol.* **51**:520 (Oct.) 1939.

Darier gave the name psorospermiosis to the disease described by him, but later investigators showed that it consisted of an abnormal and imperfect cornification of the epithelium. Nothing is known of the etiology or pathogeny of the disease, and treatment has had little influence on its course. It appears to be hereditary and familial, arises between the ages of 8 and 16 years and generally persists for

life. Except for slight pruritus in some persons, it is subjectively silent. The sites of selection are the areas vulnerable to seborrhea. Oral localization has been previously observed, but only in association with widespread cutaneous lesions. On the hard palate the lesions are typical; in other oral areas, as the gums, cheeks and tongue, the type is somewhat modified. The typical lesion is an isolated, raised papule, umbilicated and cornified, but in the mucosa the papules form groups, with a slightly hyperemic base. Abbate observed the condition, limited to the mouth, in a man aged 50 who consulted him for mucous cysts of the nasal vestibule. The dyskeratosis, discovered incidentally, was localized in the mucosa of the hard palate, gums, cheeks and tongue. There were no cutaneous lesions. The coexistence of these two distinct diseases in the same region, the superior maxilla, suggests the possibility that they have a common origin, the assumption being that both are the expression of disordered embryonal development, such disorder being manifested through the action of endogenous or exogenous agents.

DENNIS, San Diego, Calif.

ABSCESS OF THE PARAPHARYNGEAL LYMPH GLANDS FOLLOWING INFECTIONS OF THE THROAT. RICHARD WALDAPFEL, *Pract. oto-rhino-laryng.* 2:69 (April) 1939.

Waldapfel groups the complications of angina, or infections of the throat, into: (1) the hematogenous form, in which an infection from the tonsils and the thrombosed tonsillar veins may pass directly into the blood stream without involvement of the cervical or pharyngeal glands and without formation of an abscess; (2) the lymphogenous form, in which infection of the blood stream may come from the regional infected glands or abscess, causing periphlebitis or thrombophlebitis of the larger veins, and (3) the interstitial or phlegmonous form, in which there is an invasion of the parapharyngeal spaces, either toward the mediastinum or cephalad, with or without involvement of the veins, and either proximal or distal to the primary focus of infection. It is the third group that he emphasizes in his discussion, that is, that in which frank abscesses occur in the pharyngeal spaces.

He presents a group of patients in whom inflammatory swelling in the neck followed infection of the throat. While this infection may be recent and rather severe, it is not necessarily always so, since some of his patients complained of only the mildest and most transient symptoms referable to the throat. The swelling in the neck varies from the size of a plum to that of a small apple. It is usually rather hard, somewhat painful to the touch and generally adherent and the overlying skin is not freely movable. However, fluctuation is not always present. The tonsils invariably appear rather innocent, in that they do not show either an acute process or any evidence of the origin of the infection. The pharynx is usually asymmetric because of the swelling of the lateral oropharynx or hypopharynx. The temperature in his cases was not particularly significant, ranging from subnormal to only slightly elevated. However, when he observed a marked sudden rise of temperature, he always suspected a generalized spread of the infection. The local symptoms are usually only slight in the early stages. Frequently pain is referred to an ear, and then, with the increase in swelling, there is some difficulty in swallowing and some limitation of motion of the head. Pathologically, there is evidence of an abscess of the cervical lymph glands which extends and spreads into the parapharyngeal spaces. The course of this abscess varies. First, complete resolution with resorption of the exudate and complete return of the gland to normal size and function may occur. Second, contact infection of the veins in the vicinity may develop, with subsequent thrombophlebitis and septicemia. This usually is due to a spread of the infection, arising from the glands that surround the regional veins and thus, by contiguity, causing the thrombophlebitis. In these cases, evidence of encapsulation of the diseased process was not usually observed. Finally, the third course is breaking down of the glands and formation of an abscess. This is a slow progressive course, the glands usually becoming confluent; a rather dense capsule is formed, and the abscess slowly spreads both

externally toward the skin and internally into the parapharyngeal spaces. Because of the slower course and the accompanying inflammation, adhesions and pocketing of the subcutaneous tissues are frequent. The cause of the differentiation into the three pathologic groups is uncertain, but the author suggests that it may depend on either the virulence of the organism or the resistance of the patient. He differentiates cervical adenopathy from actinomycosis, glandular involvement in leukemia and other dyscrasias of the blood, malignant adenitis (which may be metastatic from another source) and chronic cervical lymphomas.

The treatment in the first stage is expectant, that is, application of antiphlogistics—heat, infra-red rays and short wave therapy. The abscess rarely ruptures spontaneously unless there is an extensive underlying disease or complication. However, should the infection continue into the second stage, with a progression of symptoms, such as laryngeal edema, a sudden rise in temperature, chills or a marked spread of the infection to the vertebrolaryngeal spaces, as seen by roentgen examination, surgical intervention is necessary. The external approach should be used. The postoperative course is usually uneventful, unless the patient has generalized septicemia, which must then be treated per se.

In conclusion, the author states that the connective tissue of the skin has two main roles. It can favor the spread of a suppurative process in either an upward or a downward direction, and, secondly, it is capable of encapsulating this process and so limiting its progress. It is in this manner that it plays an important role in complications of any infection of the throat.

PERSKY, Philadelphia.

### Larynx

LARYNGEAL TUBERCULOSIS. PIQUET, BOURY and CANONNE, *Rev. de laryng.* **60**:313 (April) 1939.

Laryngeal tuberculosis is occasionally found in an apparently healthy patient. Latent pulmonary tuberculosis is discovered by careful examination. In general, vegetative masses develop, although infiltration and deep ulceration are common. Clinical diagnosis is difficult, even impossible. Biopsy may not be conclusive. The state of the laryngeal lesion parallels that of the pulmonary one; hence the treatment must be directed to the pulmonary condition. The laryngeal lesion may heal spontaneously or may require galvanocautery.

BATSON, Philadelphia.

INDICATIONS FOR AND ADVANTAGES OF TRANSVERSE INCISION OF THE SUPERFICIAL TISSUES IN TRACHEOTOMY. E. PALLESTRINI, *Arch. ital. di otol.* **51**:234 (May) 1939.

Pallestrini advocates the use of a transverse incision in the soft tissues in tracheotomy, especially in cases in which the trachea is compressed or dislocated by an extratracheal growth or in which the operation is performed as a preliminary to external operations on the larynx or pharynx. In his experience in many cases, the cutaneous wound has always healed by first intention, because the pocketing that occurs at the lower end of the wound in the classic operation is avoided and hence soiling by tracheal secretions does not occur. By this method, retraction of the isthmus of the thyroid gland without injury is facilitated; high tracheotomy is possible; tissues which must be invaded in a secondary operation are not disturbed; closure of the tracheal wound after need for the tube is over is rapid, and the superficial scar is almost invisible.

DENNIS, San Diego, Calif.

REGARDING DYSPHAGIA IN LARYNGEAL TUBERCULOSIS. ALEXANDER ILJISCH, *Monatschr. f. Ohrenh.* **73**:369 (June) 1939.

On the basis of the experiment of Rethi on the act of swallowing, the author explains the production of dysphagia as a result of infiltration of the false cords.

In swallowing, the cords are shortened and thickened, and no doubt the false cords act likewise. This change in the structure of the false cords associated with a tearing of the underlying arytenoid gland of Morgagni can at times produce pain in swallowing, although ulcerations are absent. In cases of ulceration of the false cords, pain is observed when the infiltrated areas approximate each other. The prognosis of dysphagia caused by infiltration of the false cords is good, as the lesions can be influenced by treatment (although no details of therapy are discussed by the author).

LEDERER, Chicago.

AN OPEN, BENT SAFETY PIN IN THE ESOPHAGUS. G. CLAUS, *Monatschr. f. Ohrenh.* **73**:669 (Oct.) 1939.

From a 23 years old woman, a double-twisted, open safety pin was removed by covering the upward turned point with the introduced endoscope.

LEDERER, Chicago.

## Nose

OSTEOMYELITIS OF THE FRONTAL BONE. S. R. SKILLERN, *Ann. Otol., Rhin. & Laryng.* **48**:392 (June) 1939.

The author discusses the views of others regarding the causation of osteomyelitis, most of them feeling that trauma, either operative or accidental, is a prime factor. Swimming also is regarded as a common cause. The staphylococcus is the organism most frequently found. Skillern believes that in the majority of cases osteomyelitis of the calvarium following surgical intervention on the sinuses is due to inadequate intervention at the original operation. In cases in which involvement of bone is suspected he advocates triweekly roentgen study, recognizing at the same time that roentgen evidence of involvement is about ten days behind the actual process.

It has been the author's experience to find the point of rupture for frontal empyema to be in the roof of the orbital plate rather than at the inner angle of the eye, where it might be expected anatomically because of the dependent areas there.

In frontal sinuses in which the walls are of pure compact bone, the first evidence of osteomyelitis is generally found at the junction of the anterior and posterior walls, as there is always cancellous bone there capable of spreading the infection.

The author feels that conservatism should be the rule in acute disease of the frontal sinus until the temperature and other acute symptoms subside, provided that intranasal drainage has been established without incision. If, on the other hand, the pressure in the sinus is so great as to demand surgical drainage, he feels that a small trephine opening predisposes to osteomyelitis as the opening is in constant contact with the secretions, and he feels that if sufficient bone is removed to clean out the entire cavity the chances of complications are less. After this the remaining bone may be removed in a clean field.

The great bulk of the venous drainage of the skull pierces the inner table and empties into the meningeal vessels and blood sinuses; thus any infective exudate reaching these channels may produce thrombophlebitis of the efferent diploic channels and by retrograde thrombosis infect the bone.

It has been shown at autopsy that septic thrombosis in a vein may cause an exudate over the dura far in advance of any evidence of infection in the bone, thus proving that changes on the dura are not simply secondary to diseases of the bone.

Most of the cranial vault gets its blood supply from the meningeal arteries, which supply the dura and send a dense network through the internal table to supply the bone; little enters the bone from the external periosteum. Because of this it is easily seen that a swelling or an exudate on the dura may cut off the blood supply to the calvarium, and it explains why in some cases the inner plate may alone be involved.

Because the veins of the mucosa of the frontal sinus communicate directly with the dural veins, septic thrombosis of these vessels may readily distribute the infection to the dura, brain or skull. This seems to explain why the frontal sinus produces osteomyelitis and abscess of the brain in more cases than do all the other sinuses combined. Low grade infections, however, such as are present in chronic involvement, produce osteogenesis and thicken the walls of the sinus, sometimes even obliterating the cavity, and by this thickening of bone prevent intracranial involvement. Acute exacerbation of a chronic infection may produce osteonecrosis in thickened bone, and, if this can be checked before invasion of new tissue occurs, the thickened bone prevents spreading of the involvement and one has a self-limiting type which responds well to conservative surgical treatment.

The author feels that all frontal sinuses which require operation probably have some extension of the infection and advocates thorough curettage of all softened bone and hemorrhagic osteitis. He does not hesitate to remove the posterior wall of the sinus and expose the dura. He prefers the transeyebrow incision, the elevation of a periosteal skin flap to the limit of the sinuses, the use of a small central trephine for probing, of the Killian V chisel for incising the bone above the superciliary ridge and of rongeurs for the removal of sufficient bone to curet and cleanse the sinal cavities, the treatment of the sinus with an antiseptic bath and then the removal of all the remaining anterior wall. By this procedure the operator can inspect the entire cavity, and if he notes an osteomyelitic area he can attack it according to his best judgment. He feels that it is wise to give preoperative and postoperative transfusions and has found bacterial antigens helpful. If osteomyelitis or abscess of the dura or the brain has necessitated the removal of the posterior wall of the sinus the dura is covered with strips of sheet rubber and these are covered with a single layer of gauze, which is kept saturated every second hour with lysated bacterial fluid. The periosteal skin flap is closed with a drainage tube through the temporal incision. It is routine to place a rubber drainage tube through the enlarged osteum into the nose. When the wound is clean at a secondary operation the author advocates the chipping of small bone flakes from healthy bone and scattering them over the dura as an aid to the development of new bone.

A number of cases are reported, and it is announced that a moving picture film is available to the medical profession on request to the author.

M. V. MILLER, Philadelphia.

DISCUSSION ON ANTRAL INFECTION OF DENTAL ORIGIN. Proc. Roy. Soc. Med.  
**32:1015** (June) 1939.

A. T. Pitts stated that there are three ways in which infection of the antrum may arise from a dental cause:

1. As the result of chronic dental infection.
2. As the result of acute dental infection.
3. As the result of an accident in the course of dental treatment whereby the antrum is opened.

He expressed the opinion that the first two ways are uncommon and that the great majority of infections occur when the antrum is opened in the course of extraction or when a tooth or a root is pushed into the antrum during a dental operation. In the latter case if simple efforts are not successful in removing the tooth or root the patient should be sent to a rhinologist for operative removal.

E. A. Hardy cited statistics showing that antral disease has been attributed to oral rather than nasal origin in 8 to 50 per cent of cases. He described a method of closing the alveolar fistula by use of a plastic flap.

A. J. Wright discussed further the etiology and pathology of antral infection as related to dental conditions. He expressed the opinion that ascending alveolar osteitis is responsible in many cases for antral infection. The various possible methods of treatment were also discussed briefly.

E. D. Davis commented on the origin of antral infection, particularly in relation to the loss of a root or tooth in the sinus. He expressed opposition to enlarging the opening in the alveolus to remove the root or tooth for fear of a fistula's developing.

H. S. Stones expressed the opinion that the possibility of infection of the antrum in chronic paradontal infections is rather remote.

W. A. Mill stated that in his experience infections of the teeth were not common as a cause of antral infection.

CAMPBELL, Philadelphia.

### Miscellaneous

NONSURGICAL TREATMENT OF DISEASES OF THE NOSE AND PHARYNX. GORDON D. HOOPLE, *Ann. Otol., Rhin. & Laryng.* 48:73 (March) 1939.

The literature of the past five years is reviewed. Emphasis is placed on conservative treatment of acute sinusitis, the minimum intranasal traumatism during the acute stages being advocated. The author also calls attention to the frequency of an unrecognized systemic condition underlying the nasal condition. Rest, elimination, heat and diet are stressed.

M. V. MILLER, Philadelphia.

DERMATOLOGIC CONDITIONS OF THE EAR, NOSE AND THROAT. FREDERICK A. FIGI, *Ann. Otol., Rhin. & Laryng.* 48:81 (March) 1939.

Dermatologic conditions of the ear, nose and throat may be entirely local processes, but more commonly they are local manifestations of some systemic condition. Various local conditions are mentioned, arising from dyscrasias of the blood (such as anemia, leukemia and achlorhydric anemia), from infections (such as typhoid fever, tularemia, tuberculosis and syphilis) and from fungi. They are of interest to otolaryngologists not only because of the therapy but also because of their diagnostic and prognostic importance in general disease.

M. V. MILLER, Philadelphia.

DOES SUBEPITHELIAL EXTENSION OF INFECTION FROM THE UPPER RESPIRATORY TRACT TO THE LOWER OCCUR? AN EXPERIMENTAL STUDY. ROBERT E. VOTAW, *Ann. Otol., Rhin. & Laryng.* 48:103 (March) 1939.

Experimental work done on rabbits failed to show definite subepithelial extension from the sinuses to the rest of the respiratory tract. It did show enlargement of lymphoid tissue in the neck and lungs, which seems to argue in favor of a lymphatic route for the infection.

M. V. MILLER, Philadelphia.

THE INHIBITORY EFFECT OF SULFANILAMIDE ON WOUND HEALING. EUGENE M. BRICKER and EVARTS A. GRAHAM, *J. A. M. A.* 112:2593 (June 24) 1939.

Bricker and Graham conducted a series of experiments on 28 dogs, after satisfactory standardization of their procedure, to determine what inhibitory effect, if any, sulfanilamide may have on the healing of wounds. They used the method of Harvey and his associates in their experiments on the healing of wounds, in which the tensile strength is the indicator of fibroblastic growth. They describe their experiment as follows:

"Healthy stock dogs were used. Sulfanilamide . . . 3 Gm. daily was given for three days prior to operation. This dose ranged between 0.1 and 0.2 Gm. per kilogram of body weight. The drug was given by mouth in 1.5 Gm. doses twice daily. At operation a 2 cm. incision was made into the fundus of the stomach on the anterior surface. The wound was closed with two layers of 000 plain catgut. A blood sample was taken from the treated dogs for sulfanilamide determination. The dogs were killed three, five and seven days after the operation."

The authors present a chart, which shows a decidedly lower curve for the tensile strength in the wounds of the dogs having received sulfanilamide than for that in the wounds of the controls, but after the seventh day the tensile strength rose to nearly that of the control animals. (Harvey and his associates have shown that there is a "lag phase" of three to four days before fibroblastic growth reaches a maximum velocity.) The authors conclude:

"Sulfanilamide, given to dogs in doses comparable to the therapeutic doses used by human beings, has an inhibiting effect on the healing of uninfected incised wounds, as determined by the tensile strength."

GORDON, Philadelphia.

THE VESTIBULAR SYSTEM WITH POSTENCEPHALITIC PARKINSONISM. L. KILENYI, *Arch. ital. di otol.* **51**:134 (March) 1939.

Kilenyi reports the results of vestibular examination of 26 patients with post-encephalitic parkinsonism. The caloric test of Veits-Germán, modified by Kilenyi, was used: With the patient's head inclined 30 degrees forward, 10 cc. of water of 2 C. was injected into the ear during five seconds; the head was left in position for sixty seconds and then inclined backward at the rate of 9 degrees in two seconds. With this technic nystagmus occurs after a latency of two to three seconds and lasts sixty to ninety seconds. Each patient was submitted to three examinations at intervals of two or three days, the average values of the last two examinations being used to control those of the first examination. In no case was hyperexcitability or bilateral inexcitability observed. In 23 per cent of cases monolateral inexcitability was noted; in 46 per cent, bilateral hypoexcitability; in 46 per cent, monolateral hypoexcitability, and in 15 per cent, bilateral normal excitability. (Bilateral hypoexcitability in 1 and monolateral hypoexcitability in 2 of these were observed at the last examination.) The absence of cochlear symptoms and of obvious lesions of the drum membrane indicates a lesion of the central vestibular pathways. The hypoexcitability observed points to a more or less complete interruption in the central course of the vestibular pathways, perhaps localized in the vestibulomesencephalo-oculogyric neuron. The state of vestibular excitability has no homolateral or heterolateral relation with the postencephalitic manifestations, and there is no correspondence between improvement of the hypoexcitability and objective improvement of the symptoms of the disease.

DENNIS, San Diego, Calif.

TRYPFLAVINE [ACRIFLAVINE HYDROCHLORIDE]. R. SCHNITZER, *Prac. oto-rhino-laryng.* **2**:97 (April) 1939.

The author discusses acriflavine hydrochloride as a chemical agent against both bacterial and protozoan infections. It can be used either alone or in combination with other drugs and has shown excellent results in a large series of experimental studies on mice. He suggests further experiments and observations on human beings.

PERSKY, Philadelphia.



## Book Reviews

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**The Art of Anaesthesia.** By Paluel J. Flagg, M.D., Anesthetist, New York. Sixth Edition. Price, \$6. Pp. 491, with 161 illustrations. Philadelphia, London, Montreal: J. B. Lippincott Co., 1939.

This edition is fully up to the high standard of the previous editions in all phases of the subject and abreast of the times in the fast changing field of modern anesthesia.

While maintaining the simplicity and readability which made the other editions understandable by any one interested in anesthesia, the author gives revised and full discussions of the newer agents and the methods of their administration; at the same time, he does not neglect the older agents and methods. All of the agents are covered, the advantages as well as the disadvantages of each being given.

One of the present day problems is the choice of the agent for a selected surgical procedure; the author considers this phase in more detail than he did formerly.

The many seemingly small points that enter into a consideration of modern anesthesia, such as premedication, position of the patient and after-care of anesthetized patients, are clearly pointed out.

This new edition will be of great help to the inexperienced, as well as the experienced, anesthetist.

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## News and Comment

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### AMERICAN BOARD OF OTOLARYNGOLOGY EXAMINATION

The American Board of Otolaryngology will hold an examination at the Manhattan Eye, Ear and Throat Hospital, New York, June 3, 4 and 5, 1940.

# Directory of Otolaryngologic Societies \*

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## FOREIGN

### COLLEGIUM OTO-RHINO-LARYNGOLOGICUM AMICITIÆ SACRUM

President: Dr. Louis Ledoux, Brussels, Belgium.

Secretary: Prof. Dr. C. E. Benjamins, Verlengde Heereweg 143, Groningen, Netherlands.

### HUNGARIAN OTOLARYNGOLOGICAL SOCIETY

President: Dr. V. Zimányi, Zárda-u. 48, Budapest II.

Secretary: Dr. G. Kelemen, Reáltanoda-u., Budapest IV.

### SOCIEDAD RIOPLATENSE DE OTO-RHINO-LARINGOLOGÍA (ARGENTINE SECTION)

President: Dr. Raul Becco, B. Mitre 1690, Buenos Aires.

Secretary: Dr. Juan Manuel Tato, Santa Fé 1171, Buenos Aires.

### SOCIÉTÉ FRANÇAISE D'OTO-RHINO-LARYNGOLOGIE

Secretary: Dr. Henri Flurin, 19 Avenue Mac-Mahon, Paris, 17<sup>e</sup>.

## NATIONAL

### AMERICAN MEDICAL ASSOCIATION, SCIENTIFIC ASSEMBLY, SECTION ON LARYNGOLOGY, OTOTOLOGY AND RHINOLOGY

Chairman: Dr. A. W. Proetz, 3720 Washington Blvd., St. Louis.

Secretary: Dr. Leroy A. Schall, 270 Commonwealth Ave., Boston.

Place: New York. Time: June 10-14, 1940.

### AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Frank Brawley, 30 N. Michigan Ave., Chicago.

Executive Secretary: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.

Place: Hotel Cleveland, Cleveland. Time: Oct. 6-11, 1940.

### AMERICAN BRONCHO-ESOPHAGOLOGICAL ASSOCIATION

President: Dr. Lyman Richards, 319 Longwood Ave., Boston.

Secretary: Dr. Paul Holinger, 1150 N. State St., Chicago.

Place: Waldorf-Astoria Hotel, New York. Time: June 5, 1940.

### AMERICAN LARYNGOLOGICAL ASSOCIATION

President: Dr. James A. Babbitt, 1912 Spruce St., Philadelphia.

Secretary: Dr. Charles J. Imperatori, 108 E. 38th St., New York.

Place: Westchester Country Club, Rye, N. Y. Time: May 27-29, 1940.

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\* Secretaries of societies are requested to furnish the information necessary to keep this list up to date.

## AMERICAN LARYNGOLOGICAL, RHINOLOGICAL AND OTOLOGICAL SOCIETY, INC.

President: Dr. Lee M. Hurd, 39 E. 50th St., New York.

Secretary: Dr. C. Stewart Nash, 708 Medical Arts Bldg., Rochester, N. Y.

Place: Waldorf-Astoria Hotel, New York. Time: June 6-8, 1940.

*SECTIONS:*

Eastern.—Chairman: Dr. John R. Simpson, Medical Arts Bldg., Pittsburgh.

Southern.—Chairman: Dr. Walter J. Bristow, Doctors Bldg., Columbia, S. C.

Middle.—Chairman: Dr. Sam E. Roberts, Professional Bldg., Kansas City, Mo.

Western.—Chairman: Dr. Pierre Viole, 1930 Wilshire Blvd., Los Angeles.

## AMERICAN OTOLOGICAL SOCIETY

President: Dr. Horace Newhart, 527 Medical Arts Bldg., Minneapolis.

Secretary: Dr. Thomas J. Harris, 104 E. 40th St., New York.

Place: Westchester Country Club, Rye, N. Y. Time: May 30-31, 1940.

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## OTOMYCOSIS

TREATMENT WITH SILVER PICRATE

MERRILL O. DART, M.D.

DENVER

### HISTORICAL OBSERVATIONS

The science of bacteriology, which is so familiar, is of relatively recent origin, while the study of the fungi began centuries ago. The science of the study of the fungi, or mycetes, is known as mycology. The first recorded instance of observation of fungi is that of Hooke, who recorded his study made in 1677. While examining a rose leaf with a hand lens he found that the yellow spots seen grossly were made up of fungi. A few years later, in 1686, Malpighi described a fungus of the genus *Mucedo*, and Aspergillus was first described by Micheli in 1729.

During the remainder of the eighteenth century a number of botanists made a study of fungi, and during that century much progress was made in this science. In the nineteenth century the study of the parasitic fungi of man began to receive prominence. In 1839 Longenbeck discovered the thrush fungus at the autopsy table. Charles Robin left many records of his study of mycology, his book having remained classic. In 1843 he gave the name *Oidium albicans* to the organism Longenbeck had discovered four years before. Gruby discovered the fungus of ring-worm in 1844.

In the latter part of the nineteenth century the study of bacteriology came to the front and made such rapid strides that mycology was forced into the background. This may partially account for the uncertain state of the classification of the fungi today.

### CLASSIFICATION

An excellent classification was given by Castellani.<sup>1</sup>

From the services of Benton N. Colver, M.D., and H. J. Hara, M.D., White Memorial Hospital, Los Angeles.

Thesis submitted to the Faculty of the Graduate School of Medicine of the University of Pennsylvania in partial fulfillment of the requirements for the degree of Master of Medical Science (M. Sc. [Med.]) for graduate work in otolaryngology.

1. Castellani, A.: *Fungi and Fungous Diseases*, Chicago, American Medical Association, 1928.

. . . the *regnum vegetabile* [he stated] is usually divided into four large groups or phyla:

1. *Spermatophyta*, or seed plants.
2. *Pteridophyta*, or fern plants.
3. *Bryophyta*, or moss plants.
4. *Thallophyta*, or thallus plants.

*Thallophyta*, to which the fungi belong, are generally filamentous plants, of simple cellular structure, which differ from other plants in that they do not develop a complex plant—body with differentiation into roots, stem and leaves.

*Thallophyta* are separated into two large subdivisions:

1. *Algae* Roth, 1797, chlorophyl present.
2. *Fungaceae* Linnaeus, 1737, . . . chlorophyl absent.

*Fungaceae* . . . may be separated into three large divisions:

- (a) Bacteria, or lower fungi (*Schizomycetes*), unicellular plants, of minute dimensions, which multiply usually by cell fission.
- (b) Fungi *sensu stricte*, higher fungi, mycetes (*Eumycetes*), unicellular or pluricellular filamentous plants, of larger dimensions than bacteria, which multiply by processes other than simple cell fission, usually by means of asexual or sexual spores.
- (c) Vegetative body, a multinucleate naked plasmodium—(*Myxomycetes*), not found in man.

The study of the lower fungi, or *Schizomycetes*, Castellani explained, is now called "bacteriology," while that of the higher fungi, or *Eumycetes*, is termed "mycology."

The *Eumycetes* are subdivided into four large classes. Into these classes fall the fungi which are parasitic of man, as outlined by Castellani.

The following definitions, too, were given by Castellani:

. . . a fungus consists of (1) a vegetative part (thallus, mycelium) devoted to the acquisition of food; (2) a reproductive part. The vegetative part consists of fine filaments or threads called "hyphae;" a collection of hyphae is known as mycelium. . . . A hypha is a hollow cylindric tube containing protoplasm and divided at intervals by partitions called "septa." It may be of different shapes, straight, curved or banana-like.

On the subject of the reproduction of fungi, Castellani had this to say: the reproductive part, or the spore, is

merely a spheric, oval or elongated cell with a thin wall and containing protoplasm. A spore may multiply by budding, producing daughter spores identical with the parent spore; [or] . . . it may germinate by growing out a filament or hypha, which develops into a mycelium.

The spores belong to two types: those that are sexual in origin, and those that are asexual in origin. The asexual spores are those which are not the result of fusion of two sex cells or gametes. Practically all fungi produce asexual spores; some produce both sexual and asexual spores.

"Fungi are classified principally," Castellani went on to say, "according to the manner in which the spores are produced, their shape and their color." The principal kinds of spores he classified as follows:

1. *Gonidia* (endospores, . . . ascospores).—These spores are not born free; they are formed usually by a highly complicated process, or born in a case or receptacle, or saclike cell, which is often terminal. . . .
2. *Zygospores*.—These spores result from a conjugation of two cells (gametes) that are morphologically identical in shape, and do not show any sexual differentiation. . . .
3. *Oöspores*.—These result from the conjugation of two sexually differentiated elements. . . .
4. *Conidia* (or exospores).—These spores are born free, not in a saclike cell or case, or receptacle; the branch bearing them is called a conidiophore. Conidia originate asexually from the mycelial threads by a process of budding, septation or abstriction. . . . True [free] conidia [are] found . . . in *Aspergillus* and *Penicillium*. . . .
5. *Thallospores*.—A thallospore is merely a portion of the thallus, or vegetative body, that becomes secondarily adapted to the purposes of reproduction. There are several varieties of thallospores, the principal ones being:
 

The blastospore, which is oval or roundish, formed by . . . budding.

The arthrospore, or mycelial spore, is formed simply by the segmentation and disarticulation of a hyphal element or mycelial thread.

The chlamydospore is merely an arthrospore of large size that is undergoing encystment.
6. *Hemispores*.— . . . these are the true reproductive spores.

The four classes into which the Eumycetes may be divided are as follows (Castellani's classification):

- Class I: Reproduction by freeborn spores (conidia) that are never contained in a case or receptacle; septate mycelium— . . . *Hyphomycetes*.
- Class II: Reproduction by ascospores; mycelium septate when present—*Ascomycetes*.
- Class III: Mycelium nonseptate in vegetative stage; reproduction by zygospores—*Phycomycetes*.
- Class IV: Reproduction by basidiospores, septate mycelium—*Basidiomycetes*.

More details and the further subdivision are given in Castellani's book.

Clinically the fungi may be classified into two groups:

1. Saphrophytic: found in nature.
2. Parasitic: found in man.

The greater number are found in nature; for example, moldy bread may be due to *Mucor*, or *Penicillium*, the latter being found also on decomposed fruit. *Aspergillus* may be found on leather in damp weather or on straw. Numerous other examples could be mentioned. King Gill <sup>2</sup> stated that seventeen species of fungi had been reported as pathogenic for man and that ten different species had been found in conditions of the ear. The fungi most frequently found in the ear are the *Aspergilli*, which include *Aspergillus niger*, *Aspergillus wentii*, *Aspergillus glaucus*,

2. Gill, K.: Otitis Externa Mycotica, Arch. Otolaryng. 16:76-82 (July) 1932.

and *Aspergillus fumigatus*, *Penicillia*, *Mucoraceae*, *Monilia* and the organisms responsible for tinea. *Sporotrichi* and *Leptothrix* have also been found.

It has been pointed out repeatedly that otomycosis is more prevalent than has been taught. As proof of this, many of the examples of that disease that I have seen have been overlooked entirely or have been treated for some other condition than the true one.

Most of the texts on otolaryngology deal with this subject briefly. Beck,<sup>3</sup> in the text edited by Jackson and Coates, stated that otomycosis, or otitis externa parasitica, is comparatively rare and that the etiologic fungus is not definitely known but that the disease is believed to be due to *A. niger* and *A. glaucus*. The condition, he said, is fairly resistant to treatment. Barnhill<sup>4</sup> in his text stated: "Ear molds are found in the external auditory meatus in about one of every five hundred ear cases." Kerrison<sup>5</sup> said the fungus may remain long in the meatus and produce absolutely no symptoms.

Turner<sup>6</sup> stated he found this condition to be rare in England. He said that he treated it by syringing and by instillation of an alcoholic solution of mercury bichloride. All of the other authors cited mentioned the use of salicylic acid in alcohol.

These texts are all a number of years old, and the recent literature has taught many new things concerning otomycosis, such as the greater frequency of its occurrence and better methods of treatment. The use of salicylic acid and alcohol was advised by Bezold and is still practiced the world over, but McBurney and Searcy<sup>7</sup> demonstrated that there are at least thirty-one different solutions with a greater fungicidal power than salicylic acid in alcohol.

#### SYMPTOMS

Otomycosis is associated with the following symptoms:

1. Itching of the external canal. This may be mild or severe, intermittent or constant, but is probably present in all cases.
2. A sense of fulness, due to mechanical obstruction of the canal by the mass of mycelium and desquamated epithelium.

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3. Beck, J., in Jackson, C., and Coates, G. M.: *The Nose, Throat and Ear and Their Diseases*, Philadelphia, W. B. Saunders Company, 1929, p. 402.

4. Barnhill, J. F.: *The Nose, Throat and Ear*, New York, D. Appleton and Company, 1928, p. 448.

5. Kerrison, P.: *Diseases of the Ear*, ed. 4, Philadelphia, J. B. Lippincott Company, 1930, p. 117.

6. Turner, L.: *Diseases of the Nose, Throat and Ear*, Baltimore, William Wood & Company, 1936, p. 318.

7. McBurney, R., and Searcy, H. B.: *Otomycosis: An Investigation of Effective Fungicidal Agents in Treatment*, Ann. Otol., Rhin. & Laryng. **45**:988-1008 (Dec.) 1936.

3. Loss of hearing, also due to obstruction of the canal. It may be associated with tinnitus.

4. Aching or dull pain. This symptom may be present but does not always occur.

5. Discharge. Many patients complain of a discharging ear, which is due entirely to the condition in the external canal.

#### FINDINGS

Furuncles and secondary infection frequently occur, due to mechanical irritation and trauma produced in an attempt to relieve the itching or to bacterial invasion of the underlying structures.

Hatch and Row,<sup>8</sup> who reported 22 cases of aspergillus infection observed during one month of the rainy season in a hospital in Bombay, India, divided the conditions into two types: (a) wet, with discharge and furuncles, and (b) dry, with crusts. Most of the lesions I have seen have been of the moist type. The moist mass filling the ear has been described by various writers as having the appearance of wet blotting paper, of wet newspaper or of wet cotton, as a mealy, pultaceous mass and as a pulpy mass.

A portion of this mass is made up of macerated epithelium. W. D. Gill<sup>9</sup> once said that normal cerumen seemed to him to be absent in cases of this disease and that one is led to believe that normal cerumen inhibits the growth of fungi. However, three years later Castellani<sup>1</sup> said the presence of fungi may apparently facilitate the formation of a wax plug. W. D. Gill<sup>10</sup> later stated: "The presence of cerumen in the ear apparently exerts a restraining influence against invasion with fungi, but this is not always true, for instances have been encountered in which fungi were actually growing on a ceruminous plug."

According to my experience, cerumen does not often occur, but fungous growth has been observed on a wax plug. Although cerumen is not ordinarily found,<sup>9</sup> it may be present. Inflammation of the external canal is frequently found. The tympanic membrane may be inflamed, thickened or perforated. If secondary pyogenic infection has complicated the picture there may be a foul discharge or furunculosis.

In the dry type of this infection the mass is not so large. There is a tendency toward scales, scabs and crusting. However, the canal may be found filled with this dry debris.

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8. Hatch, W. K., and Row, B.: Fungus Disease of the Ear, *Lancet* **2**:1561-1564, 1900.

9. Gill, W. D.: Mycotic Infections in Otolaryngology, *Texas State J. Med.* **31**:272-278 (Aug.) 1935.

10. Gill, W. D.: Mycotic Infections in Otolaryngology, *South. M. J.* **31**:678-685 (June) 1938.



## PATHOLOGY

It is possible for the fungus to be present in the ears without causing symptoms or producing any pathologic changes, but if any water enters the ear trouble begins. Outbreaks are frequently seen soon after the swimming season opens. Maceration occurs; the fungus grows, and actual penetration of the skin by the mycelium may occur. There may be simply inflammation of the lining of the canal and the tympanic membrane.

If secondary pyogenic invasion has occurred it may produce marked general swelling of the canal, or the condition may be localized as a furuncle, single or multiple. Perichondritis together with marked destruction has been reported. Extension to involve the skin of the face may occur.

Castellani stated the opinion<sup>11</sup> that there are two factors which act in producing the pathologic condition: (1) the mechanical irritation and (2) a chemical irritation produced by toxins secreted by the fungus. This toxin<sup>11</sup> may cause intense reaction in the skin of the canal and lead to necrosis and perforation of the ear drum. Plaut<sup>12</sup> made the statement that when there is involvement of the tympanic membrane the disease occasionally leads to perforation. Chisolm and Sutton<sup>13</sup> reported 2 such cases in their series. Salzberger,<sup>14</sup> in discussing complications of otomycosis, said: "Perforation of the tympanic membrane and invasion of the middle ear and mastoid cells may occur." Trexler,<sup>15</sup> working in Hawaii, reported treating 10 patients with perforated tympanic membranes, who said they had not had any previous signs or symptoms of otitis media. He said he felt that this was "far too large a number to be regarded as purely incidental." He added: "In each case the drum membrane appeared gray and thickened, and the sensitivity was markedly decreased." He stated the opinion that the condition may have resulted from the symbiotic action of the fungi plus the bacteria. W. D. Gill<sup>9</sup> did not observe this in his report. Mycotic infection may occur in the middle ear complicating an already existing otitis media.

## DIAGNOSIS

From the symptoms and characteristic physical findings the diagnosis is simple, if one is thinking of this condition. Some of the conditions

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11. Castellani, quoted by Chisolm and Sutton.<sup>13</sup>

12. Plaut, quoted by Chisolm and Sutton.<sup>13</sup>

13. Chisolm, J. J., and Sutton, A. C.: Otomycosis: Report of Nine Cases Treated with Potassium Iodide, *Arch. Otolaryng.* **2**:543-556 (Dec.) 1925.

14. Salzberger, M.: *Aspergillus niger* als Ursache von Ohrerkrankungen in Palästina, *Monatschr. f. Ohrenh.* **63**:448-454 (April) 1929.

15. Trexler, C. W.: Otomycosis in Hawaii, *Laryngoscope* **45**:106-109 (Feb.) 1935.

which might be confused with it are<sup>16</sup> furunculosis, chronic otitis media, impacted cerumen, foreign bodies in the external canal and some types of diffuse otitis externa.

To identify the organism the examination of an unstained wet mount under the low power is a quick, convenient method available to any one with a microscope. Sodium hydroxide in a 10 per cent solution for the wet mount has been universally used for years, but Cornbleet<sup>17</sup> found an alcoholic solution of sodium sulfide to be superior. This solution is the best keratin dissolvent; the relationship which it produces between the refractive index of the organism and solvent is the optimum for visibility and the sodium sulfide reagent clears the solution sufficiently in five to ten minutes, while sodium hydroxide may take several hours to produce satisfactory clearing. Sodium hydroxide, moreover, may dissolve certain fungi.

To culture the fungus Sabouraud's medium may be used. Its hydrogen ion concentration is adjusted to inhibit bacterial growth and to favor fungous growth, which is best between the levels of 4 and 6.

The organism is incubated at room temperature and a good growth frequently occurs in a few days, but the culture should not be reported negative until after two weeks.

#### CASES REPORTED IN THE LITERATURE

Reference has already been made to the report of Hatch and Row,<sup>8</sup> who tabulated 22 cases observed in one month. They described the symptoms and findings in each case. They expressed the opinion that the most important part of treatment is the maintenance of cleanliness and dryness, which are gained by irrigation and by the use of iodoform and boric acid powder in equal parts.

In a comprehensive paper on the subject of otomycosis, Chisolm and Sutton<sup>18</sup> first reported the use of potassium iodide in the treatment of 9 patients. They outlined their plan of treatment as follows:

1. Oral administration of potassium iodid, beginning with 5 grains [0.32 Gm.] three times a day, and increasing gradually to 15 grains [0.97 Gm.] or more three times a day. This course to be continued until the symptoms are relieved and the ear is free of discharge.
2. A period of ten to fourteen days, preferably under observation, during which time the patient takes no potassium iodid but is instructed to wipe out the canal daily with alcohol or with a 2 per cent solution of salicylic acid in alcohol.

16. Bristow, W. J.: Otomycosis: A Clinical Consideration, *Ann. Otol., Rhin. & Laryng.* **41**:578-583 (June) 1932.

17. Cornbleet, T.: Reagent for Demonstrating Fungi in Skin Scrapings, *J. A. M. A.* **95**:1743 (Dec. 6) 1930.

3. A fourteen day course of potassium iodid then follows, beginning with 10 grains [0.65 Gm.] three times a day and rapidly increasing to the maximum dosage the patient can tolerate.
4. Rest for two weeks and repeat the fourteen day course of potassium iodid. In obstinate and long standing cases two week courses with two week intervals between should be continued for at least six months.
5. It is important that no water should be allowed to enter the canal at any time and that no oils or ointments should be used in the ear.

They added that probably the potassium iodide prevents the spores from developing, rather than killing them, and stated also:

The interval between courses allows the spores to develop into mycelia which are then killed by the next course. . . . When the fungus is growing superficially it can be cured by local measures only. When it has penetrated beneath the skin we believe potassium iodid to be essential.

In 1938 Whalen<sup>18</sup> had this to say on the subject:

In all cases of fungous infection, whether localized or systemic, the iodides are of definite value. They have been used for so many years in the treatment of various obscure conditions that it is surprising that their action is not more clearly understood. It is possible that the action of the iodides is the same as that of the sulfanilamide group in fixing the toxin eliminated by bacteria or fungi. Potassium iodide has been found to be the most satisfactory form by which to obtain the effect of iodine. The initial dose of 15 grains (1 Gm.) a day is rapidly increased to 30 grains (2 Gm.) and is given for thirty days. When sodium iodide is used, 15 grains is given intravenously every three days.

Miller<sup>19</sup> reported 2 cases of injection with *Aspergillus niger*, both being of females who gave histories of having used olive oil in the ears. One patient was treated for some time by irrigation and the use of hydrogen peroxide, as well as with boric acid in a 50 per cent solution of alcohol. The condition went from bad to worse, and secondary bacterial infection developed. Miller reported permanent cure achieved by the use of salicylic acid in alcohol.

Bahre and Hansen<sup>20</sup> reported a case of otomycosis on the basis of *Sporothrix*. Fifty years ago, they wrote, Siebenmann expressed the opinion that most otomycosis is due to the *Aspergilli*. Bahre and Hansen found that infection due to *Streptothrix* is apparently more severe in its complications than is that due to one of the *Aspergilli*, producing destruction in the middle ear, and that it may even cause death. It tends to have remissions and exacerbations. *Sporothrix* infection, they said, occupies a middle position between the severe *Streptothrix* disease and the milder

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18. Whalen, E. J.: *Fungous Infection of the External Ear*, J. A. M. A. **111**: 502-504 (Aug. 6) 1938.

19. Miller, J. W.: *Otomycosis: Its Relative Frequency*, J. A. M. A. **88**:1077 (April 2) 1927.

20. Bahre and Hansen: *Otomycose auf Grund einer Sporothrixinfektion*, Arch. f. Ohren-, Nasen- u. Kehlkopf. **121**:136-139 (May) 1929.

aspergillus condition. A report of the case of *Sporothrix* infection presented by Bahre and Hansen follows (a free translation from the original article).

#### REPORT OF A CASE

A woman was hospitalized for follicular angina. She later complained of itching and pain in the left ear. Examination showed the external canal to be covered with a greenish gray mold. The outer canal and surrounding skin were found to be much reddened from inflammation. The picture suggested *Aspergillus*. The next fourteen days the reddened infiltration spread all the way across the face from the ear. A culture on Sabouraud's medium revealed *Sporothrix*. In six to eight weeks the infiltration of the skin of the face receded, but the skin of the external canal became necrotic, and for fourteen days the outer canal was covered with bloody granulations.

In the necrotic mass one could identify the fungus with hematoxylin-eosin stain. The exact cause of the infiltration of the face was not determined, but it was thought to be a question of one of three things: (1) erysipelas, (2) fungous infiltration or (3) toxic origin. In order to establish the cause two biopsies were made at fifteen day intervals. The tissues were cultured but were sterile for fungus. The report on the histologic examination was that there was no change except inflammatory reaction. The final decision was that the condition was a toxic cutaneous reaction, secondary to the mycotic infection of the ear. (A color plate of this case accompanies the original article.)

*Treatment and Course.*—A 2 per cent solution of salicylic acid in alcohol was placed in the external canal twice daily and allowed to remain for ten minutes. The fungus disappeared in three to four days, but the complications on the face were slower in being relieved and were treated with boric acid ointment. The face healed spontaneously in seven weeks, but the aural canal did not heal for three months.

Castellani<sup>21</sup> mentioned that a fungus belonging to the family *Mucoraceae*, *Lichtheimia ramosa*, Lindt 1886, is often found in the nasal mucus of horses. He reported finding a fungus belonging to this family in 2 patients with otomycosis. Both of them were horse keepers. He said that the best treatment he had found was syringing with hydrogen peroxide (2 parts) and alcohol (1 part), provided a severe inflammation is not present. He also mentioned mercurochrome and a solution of methylene blue (methylthionine chloride U. S. P.) as well as an alcoholic solution of salicylic acid.

Thévenard<sup>22</sup> reported a case of a 45 year old physician who complained of intense itching of the external canal associated with slight exudate and sufficient desquamation to fill the canal. Treatment with silver nitrate was given with little success. The culture showed the growth to be due to *A. fumigatus*. The lesion was cured with oil of cade. There was a history of a mycotic infection of the skin of the axilla, but the type of organism producing it was not established. Thévenard

21. Castellani,<sup>1</sup> p. 135.

22. Thévenard, A.: Un cas de mycose du conduit auditif, Oto-rhino-laryng. internat. 12:171 (April) 1928.

made the suggestion that there may have been a connection between the two but said he could not be sure. About the same time Père<sup>23</sup> reported a case of infection with *A. fumigatus* and one of infection with *A. niger*.

Bernfeld,<sup>24</sup> in a study of aspergillosis in Palestine, reported 8 cases in some detail, and he observed, as did Siebenmann in mid-Europe, that the condition was more prevalent during the summer than during cooler weather. In a similar study Salzberger,<sup>14</sup> working in Palestine, found that the disease occurred more often during the rainy season and predominantly in women who do the cleaning of the walls in the houses. He expressed the opinion that the fungi may be present on the walls of the houses in damp weather and may be transferred easily to the ear.

Salzberger observed that aspergillosis is usually unilateral but that it may be bilateral. Frequently on one side it is severe, while on the other it is just beginning. It usually is cured easily but may be chronic. He advised repeated irrigations for mechanical cleansing, followed by drying the ear and using boric acid powder, which relieves the pain and allows inflammation to subside. He followed this part of the treatment with the use of a 1 per cent solution of boric acid in alcohol daily for one month to kill the rest of the spores.

Viéla<sup>25</sup> in describing the symptoms mentioned that vertigo may occur as a result of pressure of the plug on the tympanic membrane. Otorrhoea, he said, is much more frequent than most people realize. He classified cases according to 4 clinical forms of the disease, viz.: (1) pseudoceruminosis, (2) pseudocholesteatoma (may be combined with true cholesteatoma), (3) pseudo-otorrhea (may be associated with pus originating in the middle ear) and (4) pseudoeczema. The prognosis is good, he said, if the condition is treated, but if it is neglected it may last for months or years, with remissions. Viéla divided treatment into three parts; a free adaptation of his outline follows:

1. Parasiticide: In order to kill the parasites beneath the skin, which if allowed to live will cause the condition to recur in six to eight days, the following procedures are expedient:
  - (a) Careful cleansing of the lamella from the external canal, followed by thorough drying.
  - (b) Instillation of salicylic acid in alcohol or of absolute or diluted alcohol,
  - or
  - (c) Use of a bicarbonate of soda solution with a bichloride of mercury solution, oil of cade and potassium permanganate in a dilution of 1:1,000 or 5 or 10:1,000 two times a day for ten minutes, which usually cures the lesions in eight to ten days.

23. Père, M.: Deux cas de mycose du conduit auditif, *Oto-rhino-laryng. internat.* **13**:149-158, 1929.

24. Bernfeld, K.: Zur Otorrhoea aspergillosa in Palästina, *Monatschr. f. Ohrenh.* **63**:200-202 (Feb.) 1929.

25. Viéla, A.: L'otorrhoea: Etude anatomo-clinique et thérapeutique, *Oto-rhino-laryng. internat.* **15**:527-533 (Nov.) 1931.

2. Insufflation of boric acid powder.
3. Painting of the canal with tincture of iodine or silver nitrate in a dilution of 1:10.

It is necessary, he said, to observe the patient for four to six months for recurrences.

Trexler,<sup>16</sup> in discussing otomycosis in Hawaii, said the role played by fungi as pathogens for man is of far more serious import than is generally recognized. He conservatively estimated 50,000 to 100,000 cases in the territory of Hawaii. He expressed the opinion that it probably is a frequent cause of deafness in the tropics. He observed the *Aspergilli* most frequently, but other fungi noted were, *Furfur*, *Mucor* and *Penicillium*. He found that daily syringing for a week, repeated at intervals for two months, and the instillation of a 1 to 2 per cent solution of salicylic acid in alcohol gave satisfactory results. The use of a 2 to 4 per cent solution of thymol in castor oil and sodium thiosulfate is also mentioned.

Kulvin<sup>26</sup> found the factors predisposing to the development of fungus in the ear to be: "(1) traumatism of foreign bodies or scratching; (2) coincidental pyogenic infections; (3) maceration of the canal wall epithelium, and (4) the indiscriminate habit of dropping oil in the ear on every complaint of pain in the ear may have some bearing in the development of the mycosis." (Most of the writers mentioned the use of oil in the ear as one of the factors in producing this condition. However, Enlows<sup>27</sup> had this to say on the subject: "Oil was long considered a factor in the inception or progress of otomycosis. [But] Miller and others have shown that this is not the case.") Kulvin reported a case of otomycosis due to *A. nigricans*. The symptoms were itching of the ears and dizziness. He observed the canals to be filled with a secretion, "not at all like the purulent discharge of an otitis media, but one which appeared like moist paper packed in the canal." He treated the growth by the use of 95 per cent alcohol and then of 1 and 2 per cent solutions of salicylic acid in alcohol. Treatment was given daily; it was painstaking, laborious and persistent, the patient being under care from November 16 to the next February 5 with evidence of recurrences during that time. She was advised to continue treatment for several weeks or months under her own physician's care. Had specific fungicides, as they are known today, been used, perhaps the results of treatment would have been better.

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26. Kulvin, M. M.: Otomycosis, *M. Bull. Vet. Admin.* **11**:361-362 (April) 1935.

27. Enlows, E. M. A.: Mycotic Diseases of the Ear, *M. Ann. District of Columbia* **4**:217-222 (Aug.) 1935.

Pinkerton and MacQuiddy<sup>28</sup> reported 2 cases of infection caused by Scopulariopsis, proved such by culture. This organism is a filamentous fungus similar in structure and action to Aspergillus and Penicillium. The cultures demonstrated mild animal pathogenicity. Simms<sup>29</sup> reported 3 cases in which aspergillus infection was treated with a 1 per cent solution of mercuric iodide in 50 per cent alcohol. He reported the conditions cured in three days, three weeks and two days respectively. He mentioned the fact that the disease may be associated with the occupation of the patient, such as grain handling, hair sorting or working in a damp moldy cellar or in a dusty atmosphere. One wonders if aspergillosis can be considered cured after only two or three days of treatment.

Chiniara<sup>30</sup> reported 8 cases of otomycosis due to Sterigmatocystis nigra, saying the fungus has been improperly classed clinically by some as A. niger. The treatment was with an alcoholic solution of iodine, which is considered classic. The use of copper sulfate and silver nitrate is also mentioned.

Tempea,<sup>31</sup> in discussing treatment of otomycosis, expressed the opinion that tincture of iodine is a specific agent even as quinine is for malaria and neoarsphenamine for syphilis and as salicylates are for rheumatism. He said that he formerly used iodides internally but had abandoned that method in favor of local applications of iodine used in connection with irrigation of the canal.

Engel<sup>32</sup> reported a case of otomycosis due to A. niger in a young woman who said she had cleaned her ear with a plant stalk. Afterward there was some loss of hearing together with itching of the canal. Examination showed redness of the canal without desquamation. There was a grayish spot on the anterior part of the tympanic membrane, which had a black center. This spot was easily removed by washing the ear. The rest of the tympanic membrane was normal. The patient had been treated previously by the use of silver nitrate in the ear. The hearing was normal after removal of the mass on the tympanic membrane and drying of the ear. In two days the hearing was again impaired and itching had returned, and the patient felt as if the ear was filling up gradually. Examination showed the canal to be hyperemic and the tympanic

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28. Pinkerton, M. E., and MacQuiddy, L. L.: Scopulariopsis in Otomycosis, Laryngoscope 46:670-673 (Sept.) 1936.

29. Simms, R. F.: Aspergillus Infection as the Cause of External Ear Diseases, South. M. J. 30:1224-1225 (Dec.) 1937.

30. Chiniara, J.: Otomycoses à stérigmatocystis nigra, Ann. d'oto-laryng., June 1937, pp. 498-506.

31. Tempea, V.: Le traitement de l'otomycose par la teinture d'iode, Ann. d'oto-laryng., March 1937, pp. 215-218.

32. Engel, R.: Un cas d'oto-mycose à "Aspergillus niger": Traitement, Oto-rhino-laryng. internat. 22:134-135 (March) 1938.

membrane to be covered again with a whitish mass, also adherent to the canal wall. White and black flakes were again removed by the use of forceps and by irrigation. The diagnosis was otomycosis due to *A. niger* in the external canal. Treatment was with a solution of silver nitrate, in a concentration of 1:30 in the ear, and with iodides internally. Engel later used collargol (a proprietary preparation of colloidal silver and silver oxide stabilized with derived egg albumin), 1:10, and also compound solution of iodine U. S. P. and a solution of mercury bichloride (Van Swieten's solution) without success. All of these remedies were taken badly by the external canal; they were therefore replaced by insufflations of zinc peroxide, but none of them had any effect on the fungus. The condition became gradually so severe that the mass could hardly be removed by irrigations. The myringitis was intense, and there were headaches and a constant oozing from the canal. Engel next tried a 2 per cent solution of mercurochrome, which diminished the inflammation. He then used a solution (1:10) of crystal violet (methylosaniline N. F.) acidified with lactic acid. This relieved the local symptoms, stopped the discharge and diminished the desquamation. Four days later the tympanic membrane was free of desquamation and the hearing normal. Eight days after the last application of crystal violet, the cone of light was visible and there was no desquamation.

#### TREATMENT

To many practitioners the treatment of fungous infection of the ear means the use of salicylic acid and alcohol. This was first advocated by Bezold and is still found in the texts and literature. Recent experimental work has provided many more specific remedies.

Myers,<sup>33</sup> in 1927, working with a yeast infection of the hands of fruit handlers in the Northwest, was the first to demonstrate the effect of thymol on the fungi. He found that thymol, its isomer carvacrol and the volatile oils of mustard, cinnamon and clove possess marked fungicidal powers. A saturate aqueous solution of thymol killed the yeast in less than fifty seconds. He also found that powdered thymol in capsule, administered by mouth, is apparently absorbed and circulated in sufficient strength to have pronounced fungicidal action, according to cultural results supplemented by roentgenographic and physical observations in 2 cases of pulmonary moniliasis and 1 of actinomycosis.

Searcy and McBurney<sup>34</sup> reported, in 1929, the use of thymol in treatment of otomycosis. Since that time they have reported<sup>7</sup> on the

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33. Myers, H. B.: An Unappreciated Fungicidal Action of Certain Volatile Oils, *J. A. M. A.* **89**:1834-1836 (Nov. 26) 1927.

34. Searcy, H. B., and McBurney, R.: *Tr. Alabama State M. A.*, 1929; cited by McBurney and Searcy.<sup>7</sup>



relative fungicidal action of the various drugs which have been employed to treat this condition. The method used for the tests was that outlined by Allen and Wright,<sup>35</sup> viz. the agar cup plate method of determining the value of antiseptics. The results obtained for each drug tested were compared with those produced by a 5 per cent phenol solution, and the representation of the comparison was designated as the "phenol ratio," or "Pr.," "which gives a whole number for expressing relative diffusibility and germicidal action." The following tabulation (quoted from their article<sup>7</sup>) gives the results of the tests (figures under "R" indicate the relative order of effectiveness, or "Relative Rank"):

ACTION OF VARIOUS SUBSTANCES UPON SOME ASPERGILLI FOUND IN OTOMYCOSIS

Averages of Organisms N, W, G, F, Arranged in Order of Effectiveness

No.	Substance Employed	Pr.	R.
1.	Thymol-cresatin-alcohol .....	2.6	1
2.	Cresatin .....	2.55	2
3.	Thymol-merthiolate, 45, alcohol 95%.....	2.5	3
4.	Thymol-alcohol, 95% .....	2.5	3
5.	Castellani's solution .....	2.5	3
6.	Castellani's solution, thymol.....	2.43	4
7.	Thymol-alc., 70% .....	2.42	5
8.	Thymol, 2% aq. emulsion.....	2.1	6
9.	Merthiolate tincture, 1:1,000 .....	1.97	7
10.	Thymol-alcohol, 50% .....	1.95	8
11.	Merthiolate solution, 1:1,000 .....	1.95	8
12.	Carbolic, 12% in glycerine .....	1.95	8
13.	Thymol-gasoline .....	1.95	8
14.	Iodine tincture .....	1.88	9
15.	Carbolic, 10% in olive oil.....	1.82	10
16.	Metaphen tincture, 1:200.....	1.73	11
17.	Thymol-sodsol .....	1.55	12
18.	Zinc oxide-boric, eq. pts. ....	1.44	13
19.	Thymol-boric-iodide .....	1.4	14
20.	Alcohol-boric (Sat. solution) .....	1.1	15
21.	Thymol, 2% in yellow oxide of mercury.....	1.01	16
22.	Phenol .....	1.0	17
23.	Silver nitrate aq. ....	0.97	18
24.	Methylene blue, sat. alc. ....	0.96	19
25.	Phe-mer-nite, 1:3,000-R. ....	0.91	20
26.	Sodsol (naphtha) .....	0.9	21
27.	Mercurochrome, 5% aq. ....	0.9	21
28.	Phe-mer-nite, 1:1,000-G .....	0.89	22
29.	Mercurochrome, 2% aq. ....	0.61	23
30.	Phe-mer-nite ointment .....	0.6	24
31.	Phe-mer-nite, 1:2,000-G .....	0.57	25
32.	Fowler's solution .....	0.55	26

35. Allen, A. B., and Wright, I. S.: Determination of the Value of Antiseptics, J. A. M. A. 96:920-925 (March 21) 1931.

33. Tinct. metaphen, 1:2,500 .....	0.52	27
34. Silver nitrate, glycerine, alcohol (95%) .....	0.47	28
35. Whitfield's-alcohol (95%) .....	0.45	29
36. H <sub>2</sub> O <sub>2</sub> , 3% .....	0.30	30
37. Mercury bichloride, 0.04% aq. ....	0.23	31
38. H <sub>2</sub> O <sub>2</sub> -alcohol, 2%, in alcohol 95%.....	0.2	32
39. Salicylic, 2%, in alcohol, 95%.....	0.2	32
40. MgO-salicylic, eq. pts. ....	0.2	32
41. Hexylresorcinol, S. T. 37 .....	0.17	33
42. Pepsodent antiseptic .....	0.15	34
43. Listerine .....	0.1	35

N.—*Aspergillus niger*.

W.—*Aspergillus wentii*.

G.—*Aspergillus glaucus*.

F.—*Aspergillus fumigatus*.

Castellani's solution, mentioned in the tabulation, consists of: basic fuchsin, 1 Gm.; boric acid, a saturated aqueous solution, 1 cc.; resorcinol, 10 Gm., and alcohol (95 per cent), 10 cc.

The following list is also quoted from McBurney and Searcy: <sup>7</sup>

SUBSTANCES USED OR ADVOCATED FOR USE IN OTOMYCOSIS, THE FUNGICIDAL EFFECT  
OF WHICH HAS PROVED NEGATIVE IN ALL INSTANCES WHERE TRIED BY  
THE CUP PLATE METHOD ON A. WENTII, NIGER, GLAUCUS  
AND FUMIGATUS RESPECTIVELY

1. Alcohol, absolute.	
2. Alcohol, 95%.	
3. Alcohol, 70%.	
4. Alcohol, 50%.	
5. Alcohol, 40%.	
6. Alcohol, 30%.	
7. Copper, sulphate, 1:240.	
8. Carbolic aq.—	Carbolic, gtt. V. aq. oz. 2.
9. Carbolic aq.—	Carbolic, gtt. V. aq. oz. 1.
10. Calcium hypochlorite, grs. 2	Aq. oz. 1.
11. Glycerine-aq.—zinc sulphate	Glycerine—H <sub>2</sub> O eq. pts. oz. 1. ZnSO <sub>4</sub> , grs. 2.
12. Mercury Bichloride	HgCl <sub>2</sub> aq. 1:300,000.
13. Potassium permanganate	KMnO <sub>4</sub> aq. 1:100.
14. Potassium permanganate	KMnO <sub>4</sub> aq. 1:1000.
15. Potassium permanganate	KMnO <sub>4</sub> gr. 1, aq. oz. 1.
16. Silver nitrate	AgNO <sub>3</sub> aq. 1:16,000.
17. Sodium thiosulphate	5% aq.
18. Sodium thiosulphate	10% aq.
19. Sodium thiosulphate	15% aq.
20. Sodium salicylate	Sod. salicylate gr. 20, aq. oz. 1.
21. Tannin-alcohol	Tannin gr. X, alcohol 40% oz. 1.
22. Zinc sulphate, aq.	ZnSO <sub>4</sub> gr. 2, aq. oz. 1.
23. Zinc sulphate, aq.	ZnSO <sub>4</sub> gr. 4, aq. oz. 1.
24. Zinc sulphate, aq.	ZnSO <sub>4</sub> gr. 8, aq. oz. 1.
25. Zinc sulphate-glycerine	ZnSO <sub>4</sub> gr. 2, glycerine oz. 1.

Woodward, Kingery and Williams<sup>36</sup> tested thirty-seven derivatives of phenol with regard to their fungicidal power. Phenol itself was used as a basis for comparison. Iodine and mercuric chloride were also tested. The test organisms were *Monilia tropicalis*, *Cephalosporium* and *Sporotrichum*. These organisms were selected, after preliminary tests, as being typical of a large group of pathogenic yeasts and molds. Part of these investigators' tabulations, showing some of the results of their tests with *Monilia tropicalis*, is reproduced as follows:

Compound	Effective Dilution	Phenol Coefficient
Phenol....	1:75	1.0
Thymol.	1:2,000	26.6
Iodine.....	1:20,000	266.0
Mercuric chloride.	1:20,000	266.0

A further report on their study<sup>37</sup> showed that iodine surpasses all other drugs tested when used against water and broth suspensions. Its power to kill, however, is greatly reduced in the presence of proteins. The results of the tests of fungicidal activity under that condition are shown in the following tabulation, which accompanies their article:

## COMPARATIVE STUDY

Organism: *Monilia Tropicals*. Time: 15 Minutes.

Drug	Water Suspension (Effective Dilution)	Broth Suspension (Effective Dilution)	Hide Dust Suspension (Effective Dilution)	Vesicle Fluid Suspension (Effective Dilution)	Blood Serum Suspension (Effective Dilution)
Iodine. ....	1:75,000	1:20,000	1:5,000	1:2,000	1:1,000
N-hexylresorcinol..	1:20,000	1:15,000	1:5,000	1:2,000	1:2,000
Chlorothymol.	1:9,000	1:8,000	None*	None	None
Thymol.....	1:2,000	1:2,000	1:1,250	None	None
Sodium hypochlorite	1:7,500	1:2,500	1:750	1:500	1:500
Salicylic acid....	1:1,250	1:1,100	None	None	None
Benzoic acid....	None*	None	None	None	None
Sodium thiosulphate...	None	None*	None	None	None

\* "None" indicates that even a saturated aqueous solution was not strong enough to kill the organisms.

The same article went on to state:

Of the four commonly used drugs, presumably salicylic acid and benzoic acid enjoy a popularity of greatest duration. Under the conditions imposed, salicylic acid appears to act only in high concentration in the presence of water and broth suspensions, and fails entirely even in saturated solution in the presence of the other three substances used. Even more striking is the complete inability of benzoic acid to kill in saturated solution under any of the conditions imposed by these experiments. The same is to be said of sodium thiosulphate. . . ."

36. Woodward, G. J.; Kingery, L. B., and Williams, R. J.: The Fungicidal Power of Phenol Derivatives: I. Effect of Introducing Alkyl Groups and Halogens, *J. Lab. & Clin. Med.* **19**:1216-1223 (Aug.) 1934.

37. Woodward, G. J.; Kingery, L. B., and Williams, R. J.: The Fungicidal Power of Phenol Derivatives: II. Strength in Presence of Proteins, *J. Lab. & Clin. Med.* **20**:950-953 (June) 1935.

Woodward and his co-workers concluded the report thus: "Higher phenols have been found worthy of further clinical study in the treatment of fungus diseases. . . . A drug more specific in its action than those now available is needed."

Levine <sup>38</sup> used phenylmercuric nitrate in the treatment of 205 patients with fungous and yeast infections of the skin. He concluded that it was highly efficacious in the treatment of these conditions, producing cures in cases in which other forms of treatment had failed.

Greaves,<sup>39</sup> after working with the same drug, reported its use in the treatment of 75 patients with otitis externa and 100 with fungous infections of the skin. He was unable to find fungi in any of the cases of otitis externa, by smear, hanging drop or culture, even though the symptom was itching within the canal and though excoriations and abrasions were present as a result of scratching with the finger nail or other objects. He used a solution of phenylmercuric nitrate, in a dilution of 1:1,250 in 95 per cent alcohol, daily for thirty minutes for three to four days or longer. This part of the treatment was followed by the use of a powdered phenylmercuric nitrate of 1:1,500 strength. His conclusions were (1) that in 75 cases of otitis externa it eliminated the pain and discomfort in cases of acute forms of the disease and shortened the course and hastened the recovery in the cases in which the condition was chronic and long standing, and (2) that in 100 cases of dermatophytosis it was efficient in rapidly and effectively eliminating fungi from the lesions.

Enlows <sup>27</sup> declared the following procedure (abstracted from her article) to be her most successful treatment:

Irrigation is performed with warm physiologic solution of sodium chloride to remove debris, then gauze packs soaked with a saturated solution of aluminum acetate (N. F.) are inserted into the canal and allowed to remain twelve to eighteen hours. At the end of that time the canal is much less swollen and red. It is again irrigated and dried, and a 10 per cent solution of cocaine is instilled and allowed to remain twenty minutes. This is removed, the canal dried and Gram's iodine solution applied full strength. This course is to be followed by daily treatment thereafter for one week, after which the patient should be seen three times a week for two, three or more weeks. The daily treatment during the first week consists of the cleansing of the canal with hydrogen peroxide followed by the instillation of a thick paste of aluminum acetate. If there is a recurrence the Gram's iodine solution may be used as before, or the patient may use it at home, diluted five times. If iodine is not well tolerated the patient is instructed to use the 2 per cent aluminum acetate.

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38. Levine, B.: Use of Phenyl Mercuric Nitrate in Tinea and Yeast Infections of the Skin, *J. A. M. A.* **101**:2109-2111 (Dec. 30) 1933.

39. Greaves, F. C.: Phenyl Mercuric Nitrate in the Treatment of Otitis Externa and of Dermatophytosis, *U. S. Nav. M. Bull.* **24**:527-532 (Oct.) 1936.

In other cases cures were effected by Enlows by the use of silver nitrate, 25 per cent, followed by that of alcohol, 70 per cent.

W. D. Gill<sup>10</sup> expressed the opinion that the three essential points in the treatment of otomycosis are: (1) control of pain, (2) control of mycotic infection and (3) prevention of reinfection. Four objectives of treatment as outlined by King Gill<sup>2</sup> are:

(1) To cleanse mechanically the external canal from the meatus to the drum head as carefully as possible, avoiding any trauma or maceration of the skin, (2) to reduce local inflammation and allay pain, (3) to limit sporulation and (4) to leave the parts in such a condition as to prevent recurrence.

King Gill was also the first to call attention to the fungicidal action of metacresyl acetate, known under the trade name of cresatin (Dr. N. Sulzberger). Since that time it has been used by many and ranks first in the list of fungicides.

Whalen<sup>18</sup> summarized the methods of others and reported the following to be his method of choice (the procedure as presented here is quoted directly from Whalen's article):

The canal is first cleared of debris by irrigation and then dried by means of a blast of warm air. It is then packed with absorbent cotton saturated with cresatin. The patient is directed to remove this packing the following morning. After the packing has been removed an attendant places six drops of 1 per cent thymol in 70 per cent alcohol in the canal, the patient lying with the affected ear uppermost and remaining in this position for five minutes. This treatment with thymol drops is repeated twice a day for five days. . . . A thymoliodide powder is [then] prescribed to be blown into the canal twice a day for five days.

The use of this powder is to relieve the pruritus and to clear up the dermatitis. The local treatment is supplemented by the administration of potassium iodide orally. "The initial dose of 15 grains (1 Gm.) a day," Whalen stated, "is rapidly increased to 30 grains (2 Gm.) and is continued for thirty days." He also mentioned the aromatic oils, that is, oil of mustard, oil of cloves and oil of cinnamon, as being effective fungicides. Experimental work shows cresatin and thymol to be the top-ranking fungicides; so any treatment in which they are used would be the method of choice.

Searcy<sup>40</sup> also used thymol by mouth in 5 grain (0.32 Gm.) capsules at the ratio of 10 grains (0.65 Gm.) per 100 pounds (45.4 Kg.) of body weight, given with a glass of milk to assist in absorption. He used merthiolate and alcohol with thymol, thymol in cresatin diluted with olive oil and 1 per cent thymol added to 1 or 2 per cent iodine and boric acid powder.

Reinfection is easy, especially if the person goes swimming. To prevent reinfection, stated W. D. Gill,<sup>10</sup> "the ears should be dried afterward and 70 per cent ethyl alcohol instilled. . . ."

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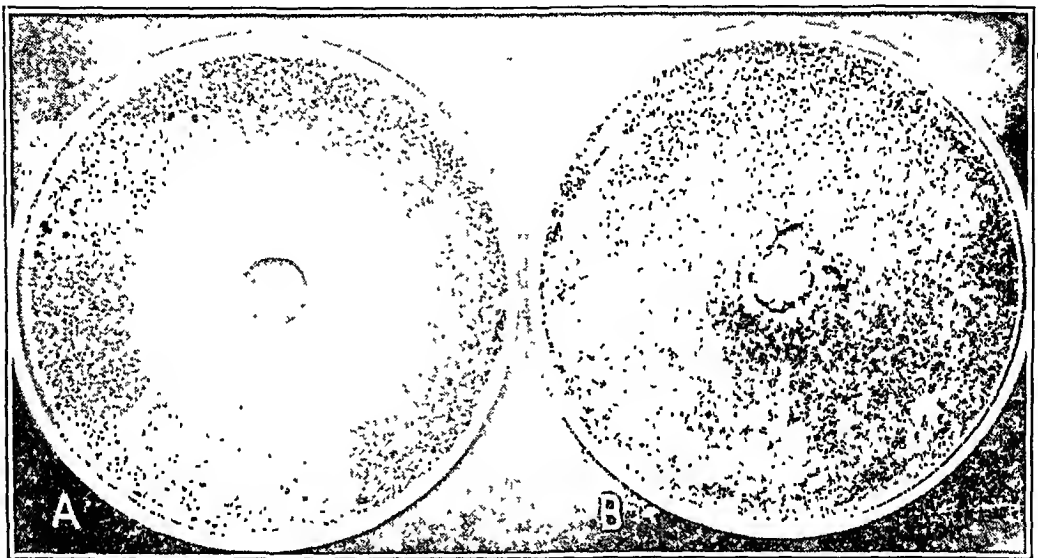
40. Searcy, H. B., in discussion on Gill.<sup>10</sup>

# EXPERIMENTATION WITH SILVER PICRATE

Since silver picrate powder has proved of value in the control of protozoon and yeast infections, I wished to try it in the treatment of fungous infections in the ear. I used it on 8 patients. Two were cured by the treatment, which included frequent cleansing of the external canal. The other 6 patients did not respond to this method of therapy. The cleansing of the canals may account for the response.

The fungicidal action of silver picrate powder was also studied in the laboratory.

The agar cup plate method of determining the value of antiseptics, as outlined by Allen and Wright,<sup>35</sup> was used. A ninety-six hour growth of *A. niger* in broth was mixed with some melted Sabouraud's medium and poured in a Petri dish. A



Agar cup plates used in testing the fungicidal action of silver picrate powder. *Aspergillus niger* was the fungus used. *A* shows the control dish, into the center of which 5 per cent solution of phenol was placed. *B* shows the dish into which silver picrate powder was placed. Inhibition of growth is clearly visible in *A*; the silver picrate powder produced no inhibition of the fungous growth.

sterile cork borer was used to remove a disk of the agar, making a cup in the center of the plate. Into this cup was placed the silver picrate powder. For a control, a 5 per cent solution of phenol was used in a similarly prepared plate.

The inhibition of the growth of the fungus by the phenol was taken as the standard. The distance from the edge of the cup to where the growth commenced was measured in millimeters.

The phenol inhibited the growth of *A. niger* for a distance of 1 cm. from the edge of the cup.

In the two plates in which silver picrate was used there was no inhibition of growth of *A. niger* at any time.

The following case reports have been summarized from my original paper in which the cases were recorded. In all cases the conditions

were diagnosed on the basis of culture of the fungi on Sabouraud's medium and on the basis of microscopic examination. The treatment of the disease in the majority of the cases was a modification of that described by Whalen,<sup>16</sup> as already outlined.

#### REPORT OF CASES

##### CASE 1.—*Monilia*.

J. B., a white man, aged 63 years, was first seen in November 1938 with a history of itching of the right ear associated with a purulent discharge for two years. Examination revealed a moist, dirty gray, foul-smelling mass filling the external canal. There was no improvement after four treatments consisting of cleansing followed by the use of silver picrate powder. Metacresyl acetate (cresatin) on a cotton wick was inserted in the external canal and allowed to remain for twenty-four hours. This treatment was followed by the use of 1 per cent thymol in 70 per cent alcohol twice a day for five days. This cured the patient, and no evidence of recurrence had appeared after several weeks.

##### CASE 2.—*Aspergillus niger*.

G. W., a white woman aged 27 years, was first seen in July 1938, complaining of marked itching of both ears, present for about three years. Recently there had been a sense of pressure and an impairment of hearing in both ears. This was found to be due to a large mass of moist, gray material with black dots on it, so often observed in *A. niger* infection. The patient had been unsuccessfully treated for this condition at various times since its onset. It was doubtless an unrecognized fungous infection. The condition did not respond to treatment with salicylic acid in alcohol or to half a dozen treatments of thorough cleansing and insufflation of silver picrate powder. It cleared up quickly when cresatin and thymol in alcohol were used. A check-up six weeks later revealed normal canals.

##### CASE 3.—*Penicillium*.

R. S., a white woman aged 69 years, was seen in June 1938 because of intense itching of the external canals for several months. There was a dry, scaly, crumbly, whitish material practically filling both canals. The past history is of interest in that the symptoms had been present for six years, and she had been treated at intervals without relief. At times there had been associated otitis media. After a two weeks' course of four treatments consisting of simple cleansing and the application of silver picrate powder, the symptoms were relieved and the canals normal; the condition remained normal after six weeks.

##### CASE 4.—*Monilia*.

M. B., a white man aged 47 years, was admitted to the clinic in October 1938, complaining of itching around the ears and in the canals for one year. The debris in the canals was of the dry type. The patient had been treated six months before for "eczema" of the ears with only temporary relief. No improvement resulted from treatment with silver picrate powder, but all symptoms and abnormal findings quickly cleared up when cresatin and thymol in alcohol and thymol iodide powder were used.

##### CASE 5.—*A. niger*.

L. C., a white woman aged 24 years, sought consultation on Sept. 9, 1938 because of (1) itching of both ears for ten years, more severe the past four years, keeping her awake at nights, and (2) an intermittent discharge from both ears for the past four years. The discharge was described as creamy and was said to have

recurred at frequent intervals without any apparent provocation. During this four year period the patient had received treatment from four physicians for a condition diagnosed to her as eczema of the ear canals. Hydrogen peroxide, ultraviolet irradiation applied to the canals and other therapeutic agents had been used. The last treatment had been for one month, six months before, but had given relief for only a short time. The canals contained a dry, scaly material. This patient was treated for a time with salicylic acid in alcohol and silver picrate powder without marked benefit. Metacresyl acetate (cresatin) and thymol in alcohol gave immediate relief. She was observed and treated with thymol iodide powder at intervals for a month and was clinically cured when discharged.

CASE 6.—*A. niger*.

G. B., a white woman aged 61 years, was seen on September 1938, complaining of pain and itching of the left ear for five days. The canal was filled with a gray, cheesy, semisolid material which gave a clinical impression of being due to a fungus. Four years previously the patient had been treated for chronic purulent otitis media of two years' standing. The ears stopped draining and had been dry until the present onset. Absence of the tympanic membrane was observed. This case illustrates fungous infection of the external canal associated with otitis media, clearing up when treated with silver picrate powder. There had been no recurrence two months later.

CASE 7.—*Aspergillus*, *Monilia*, *Penicillium*.

M. S., a man from India, aged 45 years, was seen in July 1938 at the request of the ophthalmic department. Routine questioning revealed that there had been itching of the right ear for two years but that the patient had not sought medical care for it. The right ear contained a large plug of dried cerumen, which was covered with a white growth suggesting a fungus. Inside the cerumen was found a piece of match stick about  $\frac{1}{2}$  inch (1.27 cm.) long. The patient did not know how long it had been there, but said that owing to the intense itching he had frequently used a match stick to scratch the canal. He was treated once with silver picrate powder, which relieved the itching, but evidence of fungous growth was observed in the ear in November, the next time the patient was seen. He did not return for further treatment. The condition in this case illustrates a multiple type of infection in one person.

CASE 8.—*No Report*.

K. H., a white woman aged 42 years, was first seen in December 1937 with a complaint of itching of the left external canal. There is no record of treatment. When she was seen again in July 1938, both ears were itching and there was a mass of scaly debris and dried skin which was suggestive of fungus. On Sabouraud's medium the growth was grossly typical of a fungus, but the type was not identified microscopically. The patient was treated twice by cleansing and the application of silver picrate powder. She did not return. The result of treatment is undetermined.

CASE 9.—*Aspergillus*.

S. R., a white girl aged 12 years, was admitted in April 1938 for treatment of a flare-up of chronic purulent otitis media in the left ear. The right canal was filled with a moist gray mass produced by the fungous infection. The middle ear was not involved at this time. There was constant itching of both ears. The patient was treated for a month with salicylic acid in alcohol without much success. Tincture of metaphen had produced marked improvement by the time of consultation one week later, but further follow-up was impossible.



CASE 10.—*Monilia*.

J. McK., a white girl aged 14 years, was seen in February 1938 because of itching of the ears and diminished hearing. The left external canal was filled with a moist, sour, cheesy material. The hearing was improved on the removal of this. The tympanic membranes were normal. The patient was seen four times during the next two months and treated by cleansing of the ears and instillation of tincture of metaphen; salicylic acid in alcohol was used twice daily at home. The condition gradually improved. Eight months later the patient was still free of symptoms, and there was no evidence of recurrence.

CASE 11.—*Monilia*.

M. S., a white girl aged 13 years, was seen in August 1938, complaining of intense itching of both ears of three months' duration. Both ears were filled with a dirty gray, moist, foul-smelling material, clinically of fungous origin. Some nonspecific treatment for the otitis externa was administered, and the use of salicylic acid in alcohol was producing some improvement when the patient was last seen, in October 1938.

CASE 12.—*Ringworm (probably due to Trichophyton)*.

O. R., a white woman aged 47 years, was admitted for treatment of chronic purulent otitis media complicated by a fungous infection and further complicated by a secondary bacterial infection of the canal wall. There was an associated fungous infection of the hands, which was probably the primary source of infection. The patient was cured with compound ointment of benzoic acid N. F. (Whitfield's ointment), one-half strength, and salicylic acid in alcohol, both used in the ears.

CASE 13.—*Penicillium*.

W. G., a white man aged 30 years, was seen in October 1938. He gave a history of severe itching associated with a discharge from both ears. Previous treatment had given no relief. All positive findings were in the external canals only. The use of a wick saturated with metacresyl acetate (cresatin), placed in the canals and allowed to remain for twenty-four hours, followed by a few days' treatment with thymol in alcohol and thymol iodide powder, produced a rapid and complete recovery.

CASE 14.—*A. niger*.

J. B., a white girl aged 4 years, the youngest patient in the series, was seen because of diseased tonsils and adenoids. The child was found to have a severe fungous infection of the external canals. She was treated without success with tincture of metaphen, salicylic acid in alcohol and Sulzberger's powder (boric acid with iodine). She made a quick recovery when cresatin and thymol in alcohol were used.

CASE 15.—*A. niger*.

R. L., a white woman aged 20 years, was first seen in March 1938 because of a large, sessile exostosis of the external canal. This interfered with ventilation of the canal; medial to the obstruction a large amount of debris and cerumen with a sour odor was found. The patient was given salicylic acid in alcohol to use, but in November she reported no improvement. Both ears were now itching and felt stopped up. Treatment with cresatin, thymol in alcohol and thymol iodide powder was started. In three weeks there was no complaint, and the canals were free of debris. The mechanical obstruction of the canal made it more susceptible to infection.

CASE 16.—*Rhizopus*.

M. M., a white woman aged 47 years, sought consultation for a condition due to one of the more rare fungi found in the ears. She was cured by the use of salicylic acid in alcohol.

CASE 17.—*A. niger*.

B. R., a white woman aged 40 years, was seen in May 1938 because of acute purulent otitis media, bilateral, associated with a fungous infection. She was treated with a preparation of iodine and mercury, with boric acid in alcohol and with Sulzberger's powder (boric acid with iodine) for two months. In August both ears were dry and the canals normal.

CASE 18.—*Aspergillus*.

K. J., a white woman aged 23 years, had been troubled with discharging ears accompanied by itching for four years. The condition was otitis externa due to fungus. One treatment consisting of cleansing and the application of a 10 per cent solution of silver nitrate to the canals was given. The patient did not return.

CASE 19.—*Alternaria*.

R. K., a white woman aged 28 years, had been troubled for over two years with an itching and crust formation in both canals. She had been treated many times and with many methods without relief. When the condition was finally diagnosed and specific treatment instituted, the patient made rapid improvement but was not followed up long enough for a permanent cure to be proved.

CASE 20.—*A. niger*.

D. D., a white woman aged 41 years, was seen in January 1939 with the complaint of an intense itching of the external canals associated with a stopped up feeling of the ears, present for four years. The left canal contained white, moist debris with dark areas in it. Specific treatment consisting of the use of cresatin and thymol relieved the symptoms, and the canal was normal two weeks later.

CASE 21.—*A. niger*.

S. S., a white man aged 64 years, was first seen in October 1938 because of nerve deafness. At this time the canals were normal. Three months later there was itching of the canals associated with buzzing and ringing in the ears, severe enough to keep the patient awake. Both canals contained a moist, black mass, thought to be due to fungus. Specific treatment with cresatin and thymol produced immediate improvement, but the patient was not followed up long enough for the end result to be known.

CASE 22.—*Monilia*.

L. C., a white man aged 76 years, the oldest patient in the series, was seen because of a fungous growth in the ears which had produced some loss of hearing. Two weeks after treatment with cresatin and thymol was instituted, the hearing was improved and the canals were normal.

CASE 23.—*Monilia*.

J. C., a white man aged 28 years, had a fungous infection which was discovered during routine examination for tonsillectomy. The growth was of the dry type. It was not treated.

CASE 24.—*A. niger*.

H. C., a white woman aged 39 years, was seen in January 1939 complaining of recurrent attacks of earache, frontal headache, itching of the ears and diminution of hearing, of one month's duration. There had been similar attacks previously,

*Data on Otomycosis Given in Case Reports*

Case No.	Name of Patient	Age (Yr.), Sex	Fungus	Complications	Treatment	Result
1	J. B.	63 M	Monilia	None	Silver pierate powder on four occasions..... Changed to cresatin and thymol in alcohol	No benefit Cured
2	G. W.	27 F	A. niger	None	Salicylle acid in alco- hol for six weeks..... Silver pierate powder on five occasions in three months, no home treatment..... Changed to cresatin and thymol in alcohol	Worse No benefit Quickly cured
3	R. S.	69 F	Penicillium	Long standing; previously associated with chronic purulent otitis media	Silver pierate powder only.....	Cured
4	M. B.	47 M	Monilia	Nerve deafness	Silver pierate for three weeks..... Cresatin and thymol in alcohol.....	No benefit Cured in 2 weeks
5	L. C.	24 F	Aspergillus	Long standing, ten years	Salicylle acid in alcohol..... Silver pierate..... Cresatin and thymol..	No benefit No benefit Quickly cured
6	G. B.	61 F	A. niger	Chronic otitis media with a perforated tym- panic membrane	Silver pierate only.....	Quickly cured
7	M. S.	45 M	Aspergillus, Monilia, Penicillium	None	Silver pierate only.....	No benefit
8	K. H.	42 F	Not identi- fied	None	Silver pierate powder...	No follow-up
9	S. R.	12 F	Aspergillus	Chronic otitis media; x-ray revealed chronic mastoiditis, bilateral	Salicylle acid in alcohol	Improved, but impossible to follow up
10	J. M.	14 F	Monilia	None	Tincture of metaphen in clinic; salicylle acid in alcohol.....	Cured after 6 mo. check-up.
11	M. S.	13 F	Monilia	None	First treated for nonspecific otitis externa; salicylle acid in alcohol	Reported im- proved, but impossible to follow up after finding of fungus
12	O. R.	47 F	Ringworm fungus	Chronic otitis media, puru- lent	Salicylle acid in alcohol; Whitfield's ointment, one-half strength.....	Cured
13	W. G.	30 M	Penicillium	None	Cresatin; thymol in alcohol.....	Cured
14	J. B.	4 F	A. niger	None	Tincture of metaphen; salicylle acid in alco- hol; iodine and borie acid powder..... Changed to cresatin and thymol in alco- hol.....	Still present 6 mo. later Cured in 2 wk.
15	R. L.	20 F	A. niger	Exostosis of external canal	Salicylle acid in alcohol Cresatin and thymol in alcohol.....	No relief Cured
16	M. M.	47 F	Rhizopus	None	Salicylle acid in alcohol	Cured

*Data on Otomycosis Given in Case Reports—Continued*

Case No.	Name of Patient	Age (Yr.), Sex	Fungus	Complications	Treatment	Result
17	B. R.	40 F	<i>A. niger</i>	Acute otitis media, purulent	Merodicein; boric acid in alcohol; boric acid and iodine powder.....	Cured
18	R. J.	23 F	<i>Aspergillus</i>	None	Silver nitrate, 10%, once only.....	Did not return
19	R. K.	28 F	<i>Alternaria</i>	None	Cresatin; thymol in alcohol; thymol iodide....	Improved
20	D. D.	41 F	<i>A. niger</i>	Nerve deafness	Cresatin; thymol in alcohol; thymol iodide....	Improved
21	S. S.	64 M	<i>A. niger</i>	Nerve deafness	Cresatin; thymol in alcohol; thymol iodine....	Improved
22	L. C.	76 M	<i>Monilia</i>	Nerve deafness	Cresatin; thymol in alcohol.....	Improved
23	J. C.	28 M	<i>Monilia</i>	Perforated tympanic membranes, bilateral	None.....	None
24	H. C.	39 F	<i>A. niger</i>	None	Cresatin; thymol in alcohol; thymol iodide....	Cured
25	I. G.	47 M	<i>A. niger</i>	None	Cresatin; thymol in alcohol; thymol iodide....	Improved

which were associated with a discharge from the ears. The canals were found to be packed with a soft, yellowish white, cheesy debris. Cleansing of the ears did not reveal otitis media but did restore the hearing. One month after treatment with cresatin and thymol, all symptoms mentioned had been relieved and the canals were normal.

*CASE 25.—A. niger.*

I. G., a white man aged 47 years, presented a condition which was an example of the many undiagnosed fungous infections of the ears which had been unsuccessfully treated as nonspecific otitis externa but made rapid improvement when diagnosed and treated by specific methods. The complaints were itching of the ears associated with scaly debris which kept reforming and produced a buzzing in the ears.

SUMMARY OF DATA ON REPORTED CASES

The chief data on the reported cases, presented in the accompanying table, are summarized in the following tabulations:

*Incidence of Types of Fungus*

Fungus	Total patients, 25	No. of Patients
<i>Aspergillus</i> .....		13
<i>Monilia</i> .....		7
<i>Penicillium</i> .....		3
<i>Trichophyton</i> ?.....		1
<i>Rhizopus</i> .....		1
<i>Alternaria</i> .....		1
No report.....		1
Total fungi.....		27*

\* One patient had more than 1 fungus.

*Incidence with Regard to Sex*

Sex	No. of Patients
Female.....	17
Male.....	8

## *Incidence with Regard to Age*

Age (Yr.)	No. of Patients
1-10.....	1
11-20.....	4
21-30.....	6
31-40.....	2
41-50.....	7
51-60.....	0
61-70.....	4
71-80.....	1

Youngest patient, 4 yr.; oldest patient, 76 yr.

## *Treatment and Results*

Treatment	Result	No. of Patients
Silver picrate powder.....	Relief of symptoms	2
	No relief.....	6
Salicylic acid in alcohol....	Relief.....	3
	Questionable.....	1
	No relief.....	4
Cresatin and thymol in alcohol....	Improvement.....	5
	Cure.....	8

I studied 30 additional patients in whom symptoms and findings suggested fungous infection but in whom cultures revealed no fungus.

## CONCLUSIONS

1. Otomycosis occurs much more frequently than the textbooks would lead one to believe. It is frequently overlooked in the treatment of otitis externa.

2. Otomycosis has not always been treated properly. Recent experimental work has furnished better methods of treatment.

3. Powdered silver picrate is not effective in the treatment of otomycosis.

4. Metacresyl acetate (cresatin) and thymol have the greatest fungicidal activity of any drugs now available.

# ELONGATED STYLOID PROCESS

## A CAUSE OF OBSCURE THROAT SYMPTOMS

MILO FRITZ, M.D.

DURHAM, N. C.

The purpose of this communication is to point out that the elongated styloid process is common and that it will often, if sought, be found to be the cause of obscure complaints involving the throat.

Forty-three patients having this condition were found in the private and dispensary services of Duke Hospital, 39 of them between January 1937 and September 1939. Only 11 of the 43 patients came to operation. Four of these patients had been previously reported on.<sup>1</sup>

According to Dwight,<sup>2</sup> the styloid process is derived from the second branchial arch and normally attains the length of 2.5 to 3 cm. (fig. 1). It extends from the under surface of the petrous portion of the temporal bone forward, downward and mesially. The tip is cartilaginous and in the abnormally long styloid process may fuse with the lesser horn of the hyoid bone in the form of a calcified stylohyoid ligament (fig. 2). Such a styloid process is an anatomic curiosity, but it may have clinical significance, as illustrated in case 1, in which a needle was broken off against it during the suturing in a tonsillar fossa (fig. 3). Many styloid processes that are elongated but still are not long enough to reach the hyoid bone are asymptomatic; but if they project abnormally forward and mesially into the tonsillar fossae they not only often give rise to symptoms but may interfere with tonsillectomy.

The symptoms consist of a sensation of fulness in the throat; dysphagia; pain in the throat aggravated by swallowing; dull ache or marked lightning and lancinating pain in the throat radiating to the ear and mastoid tip; a sensation described as neuralgic pain in the throat; pain and soreness in the hard and the soft palate, and a sensation of food having lodged in the throat, necessitating frequent swallowing. Occasionally symptoms are not evident until some days after tonsillectomy. For weeks or years the patient thinks the tonsillar fossa has failed to heal. These symptoms are sometimes indistinguishable from neuralgia of the glossopharyngeal nerve, which lies close to the styloid

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From the Department of Otolaryngology, Duke University Medical School and Hospital.

1. Eagle, W. W.: Elongated Styloid Processes: A Report of Two Cases, *Arch. Otolaryng.* **25**:548 (May) 1937.

2. Dwight, T.: Stylohyoid Ossification, *Ann. Surg.* **46**:721, 1907.



Fig. 1.—Two specimens of styloid processes of normal length.



Fig. 2.—An elongated styloid process that fuses with the lesser horn of the hyoid bone. The specimen was found in classroom dissection. The department of anatomy of Duke University gave permission for the specimen to be used in this study.

process.<sup>3</sup> A diagnosis of idiopathic glossopharyngeal neuralgia cannot be made until symptoms due to an elongated styloid process are eliminated by digital palpation of the tonsillar fossa and by lateral roentgenograms of the neck.

Diagnosis is established by digital palpation of the tonsillar fossae. The index finger is placed over the tonsil or in the tonsillar fossa, and the tip of the elongated styloid process is felt as a hard prominence beneath the finger tip. The type of styloid process that fuses with the hyoid bone and the type that is elongated but does not project into



Fig. 3 (case 1).—Roentgenograms of elongated styloid processes that fused with the lesser horns of the hyoid bone. They were asymptomatic, and the condition was accidentally discovered when the suture needle broke during tonsillectomy. The fragment of the needle can be seen above and lateral to the left styloid process.

the tonsillar fossa may be mistaken on palpation for the mandible, but when the condition is suspected a roentgenogram is always final in establishing the diagnosis. The elongated styloid processes that project abnormally forward and mesially into the tonsillar fossae are always palpable and most often give symptoms, and roentgenograms are only confirmatory (figs. 4 and 5).

3. Harris, W.: *Neuritis and Neuralgia*, New York, Oxford University Press, 1926, chap. 16.





Fig. 4.—An elongated styloid process also found in anatomic dissection rooms (Dr. W. B. Anderson made the specimen available for this study).



Fig. 5 (case 2).—Roentgenograms of elongated styloid processes that gave typical symptoms, which were relieved by amputation.

The treatment of the condition is entirely operative. Results obtained by fracturing the process laterally have not been satisfactory. The operative setup is similar to that for tonsillectomy. In our institution tonsillectomy is done entirely by dissection with the patient under light ether anesthesia. The Davis mouth gag and tongue blade are used to hold the mouth open and the tongue out of the operative field. Bleeding is controlled by no. 0 catgut sutures. Suction in addition to lowering of the head and elevation of the feet is used to prevent aspiration of blood. In a case in which the tonsil is superimposed over an elongated styloid process the tonsil is removed first. The tissues over the elongated styloid process are then stripped back, and the presenting tip of the process is amputated with a rongeur. In a case in which the tonsils have been previously removed a small incision is made over the tip of the elongated styloid process. The soft tissues are then bluntly dissected back from the tip, and amputation is done as far back on the shaft of the process as is deemed expedient, the proximity of the carotid artery and of the glossopharyngeal nerve being always kept in mind, as these structures might be injured. Bleeding is never troublesome; healing is prompt, and all patients so far operated on have had complete relief of symptoms.

#### REPORT OF CASES

The histories of 9 of the 11 patients who came to operation follow:

CASE 1.—A 30 year old white man was admitted to the hospital for a tonsillectomy at the recommendation of his physician, who believed that the tonsils were a focus of infection causing arthritis. During the operation, while the surgeon was suturing in the left tonsillar bed the needle point struck something hard and snapped in two. About two thirds of the needle was lost and not recovered after a search of two hours. A roentgenogram showed elongated styloid processes that fused with the lesser horns of the hyoid bone, and the needle fragment could be seen lying near the left process (fig. 3). The patient made an uneventful recovery from the operation and returned for removal of the needle fragment six months later. He has been well since.

CASE 2.—A 28 year old white woman was first seen in the laryngologic service of Duke Hospital eight years ago, because of pain over and in the left eye and in the region of the left frontal sinus, as well as transient earache, stiffness of the left temporomandibular joint, pain in the tip of the left mastoid process and pain in the left side of the pharynx. Tonsillectomy had been done twice, the last time two years before the first examination at Duke Hospital. The patient was found to have a deviation of the nasal septum to the left with a spur touching the lateral nasal wall at the posterior end of the left middle turbinate bone. Digital palpation of the tonsillar fossae was not done. When cocaine in a solution of 10 per cent was applied to the nasal mucosa in the region of the sphenopalatine ganglion on the left side there was immediate relief of the pain in the left eye and over the left frontal sinus. It was thought that the symptoms were due entirely to irritation of the left sphenopalatine ganglion by the septal spur. A submucous resection of the nasal septum, including the spur, was successfully done.

The patient was next seen six years later. She said that since recovery from the operation she had been free of pain in the left eye and over the left frontal sinus, but that she still had pain throughout the left side of the throat, soreness in the larynx and pain and tenderness in the tip of the left mastoid process and in the left ear. Examination at this time showed a Thornwaldt cyst in the nasopharynx and, on palpation of the tonsillar fossae, an elongated styloid process on the left. Pressure on the tip of the process by the examining finger caused accentuation of the symptoms described. Though the styloid process was not palpable on the right, a roentgenogram of the neck (fig. 2) showed both processes to be elongated. The one on the right was asymptomatic. At operation the Thornwaldt cyst was removed and 3 cm. of the left styloid process was amputated. The patient was completely relieved of symptoms when seen five months later and is still well.

This case well illustrates the importance of palpation of the tonsillar fossae in the presence of throat symptoms. Had that been done on the first examination the cause of the symptoms in the left side of the throat would also have been discovered. It is interesting to note that this patient has a sister and a brother, each of whom had elongated styloid processes. Each of these siblings had been seen by physicians because of throat symptoms similar to those of the patient of case 2. The cause was not discovered until that patient suggested to them the possible presence of an elongated styloid process. Such a process was found to be present. The brother was operated on and secured complete relief of his symptoms. The sister has not come to operation.

CASE 3.—A 29 year old white woman was first seen seven years ago because of severe and persistent pain in the right side of the throat. Tonsillectomy had been done eight years previous in an unsuccessful attempt to relieve the pain. Examination of the throat without palpation of the tonsillar fossae revealed lymphoid hyperplasia at the base of the tongue, and it was thought that this condition was responsible for the symptoms. Accordingly, the lymphoid tissue was treated with roentgen rays. Although the lymphoid hyperplasia subsided, the pain in the right side of the throat persisted. Six years later the patient returned branded as "neurotic" by the referring physician. Meanwhile, my associates and I had learned the importance of palpation of the tonsillar fossae, and on the patient's return we found an elongated styloid process projecting into each tonsillar fossa. Though both processes were elongated and palpable, only the right one was amputated, and the patient was completely relieved of her symptoms.

CASE 4.—A 47 year old white woman came for examination because of a dull, aching sensation in the left side of the throat and symptoms of fulness and choking of many years' duration. A tonsillectomy had been done elsewhere two years previously in an unsuccessful attempt to relieve these symptoms. In addition, the patient complained of postnasal discharge that caused her constantly to clear her throat. Examination disclosed a left antrum that failed to transilluminate and a mucopurulent discharge in the left naris. In addition, palpation revealed an elongated styloid process on the left side. A Caldwell-Luc operation was performed to clear up the infection of the left maxillary sinus. When the patient had recovered from this operation and was relieved of the postnasal discharge, she returned for amputation of 2.5 cm. of the left styloid process. She has been completely relieved of the throat symptoms.

CASE 5.—A 45 year old white woman had a constant dull, nagging pain in the right side of her throat as well as recurrent tonsillitis. Examination showed chronically diseased tonsils. Palpation of the tonsillar fossae revealed an elongated styloid process on the right side, the tip of which was easily palpable beneath the tonsil. A roentgenogram showed an elongated styloid process on each side. Since the styloid process on the left side was asymptomatic, only the right styloid process was shortened. The patient was completely relieved of her symptoms.

CASE 6.—A 41 year old woman sought consultation because of fulness and soreness of the throat together with dysphagia. Tonsillectomy with the region under local anesthesia and a submucous resection of the nasal septum had been done many years previously. Examination showed infectional hypertrophy of the adenoids and elongated styloid processes that projected markedly toward the midline. A roentgenogram confirmed this finding, and at operation about 4 cm. of each styloid process was removed. The patient was completely relieved of her symptoms when seen one year after operation.

CASE 7.—A 29 year old white man came to the hospital saying that his throat had never healed after tonsillectomy, which had been done fifteen months previously. His throat felt raw, and he had difficulty in swallowing. Palpation of the tonsillar fossae disclosed an elongated styloid process on the right. A roentgenogram showed both styloid processes to be elongated, but the right one was longer than the left. Two and five-tenths centimeters of the right styloid process was removed at operation. When the patient was seen several months later he said that the rawness and dysphagia had disappeared but that the right side of the throat seemed tight. Examination failed to reveal the cause, but it was assumed it was due to the formation of excessive scar tissue.

CASE 8.—A 62 year old white woman complained of pain in the right side of the throat of four years' duration. The pain was constant and was aggravated by swallowing. It occasionally radiated to the right ear and mastoid tip. There was a constant dull ache in the right side of the pharynx. Examination revealed chronic tonsillitis and an elongated styloid process beneath the right tonsil. A roentgenogram showed both styloid processes to be abnormally long. A tonsillectomy and adenoidectomy was done, and 2.5 cm. of the right styloid process was amputated. The patient was relieved of her symptoms.

CASE 9.—A 40 year old white woman was referred to the laryngologic service by the medical department because of a constant sore throat since a tonsillectomy in 1918. Palpation of the tonsillar fossae showed a prominent and elongated styloid process on the left, while that on the right was barely palpable. A roentgenogram revealed that both processes were elongated. At operation 5 cm. of the left styloid process only was amputated. The right styloid process was asymptomatic. When the patient was seen several months later, her throat was healed and she was relieved of her symptoms.

CASES 10 AND 11.—These cases have been reported previously.<sup>1</sup>

#### ANALYSIS OF CASES

In addition to the 11 patients who were operated on there were 32 who, for one reason or another, never came to operation. Some of these patients had had tonsillectomies, and some had not. Of these 32 patients,

16, or 50 per cent, had no symptoms, and their elongated styloid processes were discovered only because of routine palpation of the tonsillar fossae for elongated styloid processes when there were symptoms referable to the throat. The remaining 16 patients who did not come to operation complained of the aforementioned symptoms in varying combinations.

Of the 11 patients who came to operation 3 were male and 8 female. The ages ranged from 30 to 62. Tonsillectomies had been done on 8 patients, and on 3 no operation had been done. In 5 patients the condition was on the left side, in 3 it was on the right and in 2 it was bilateral. One patient was noticed because a needle had broken off during tonsillectomy against an elongated styloid process that was asymptomatic. Amputation of one or both processes during tonsillectomy and adenoidectomy was done on 3 of these patients.

Of the 16 patients who had symptoms and never came to operation, 6 were male and 10 female. The ages ranged from 22 to 71. Twelve had had tonsillectomies and 4 had not. The condition was on the left in 5 patients, on the right in 4 and bilaterally in 7.

Of the 16 patients with asymptomatic elongation of the styloid process, 4 were male and 12 were female. Their ages ranged from 30 to 78. All 16 patients had had tonsillectomies. The condition was found on the left side in 3 patients, on the right side in 7 and on both sides in 6.

One is impressed by the preponderance of the condition in the female sex as compared with the male.

#### SUMMARY

The importance of symptoms caused by elongated styloid processes is recognized.

The structure and the development of the condition, as well as the diagnosis and treatment, are discussed.

Forty-three patients having this condition are reported on.

The histories of 9 of the 11 patients who came to operation are presented and discussed.

The cases of 32 patients who did not come to operation are analyzed.

Elongated styloid processes were found in 3 members of a single family, 2 sisters and 1 brother (case 2).

# PYOGENIC GRANULOMA OF THE NASAL FOSSA

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This study is based on the examination of so-called bleeding polyps of the nasal fossa in an effort to determine whether they are nonspecific edematous polyps associated with dilatation of the vessels and secondary hemorrhage, or fibroangiomas, or whether they may be classified as pyogenic granulomas.

As far as the literature is concerned, no general agreement has been reached as to the nature of the so-called bleeding polyps of the nasal fossa. The principal point of dissension is whether they are benign fibrovascular tumors or inflammatory masses.<sup>1</sup> Most of the investigators have favored the neoplastic theory; yet there are on record numerous instances of bleeding polyps of the nasal fossa diagnosed histologically as granulomas, as simple, nonspecific inflammatory masses or as granulation tissue. However, in 1936, Simonetta and Tavani<sup>2</sup> were the first to show the similarity of the bleeding polyp of the nasal fossa to the pseudobotryomycoma, a synonym for granuloma pyogenicum.

In the 5 cases here presented the lesions were clinically typical of bleeding polyps of the nasal fossa and were regarded as fibrovascular tumors. Careful microscopic analysis, however, led us to believe that these lesions revealed the histologic characteristics usually seen in cases of so-called granuloma pyogenicum.

## REPORT OF CASES

CASE 1.—A 16 year old boy complained of severe attacks of nosebleed occurring over a period of several days. A dark red polyp which bled on the slightest contact was seen arising from Kiesselbach's area. Further otolaryngologic and general physical examination gave negative results. The growth was removed

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This study was aided by a grant from the Otto Baer Fund.

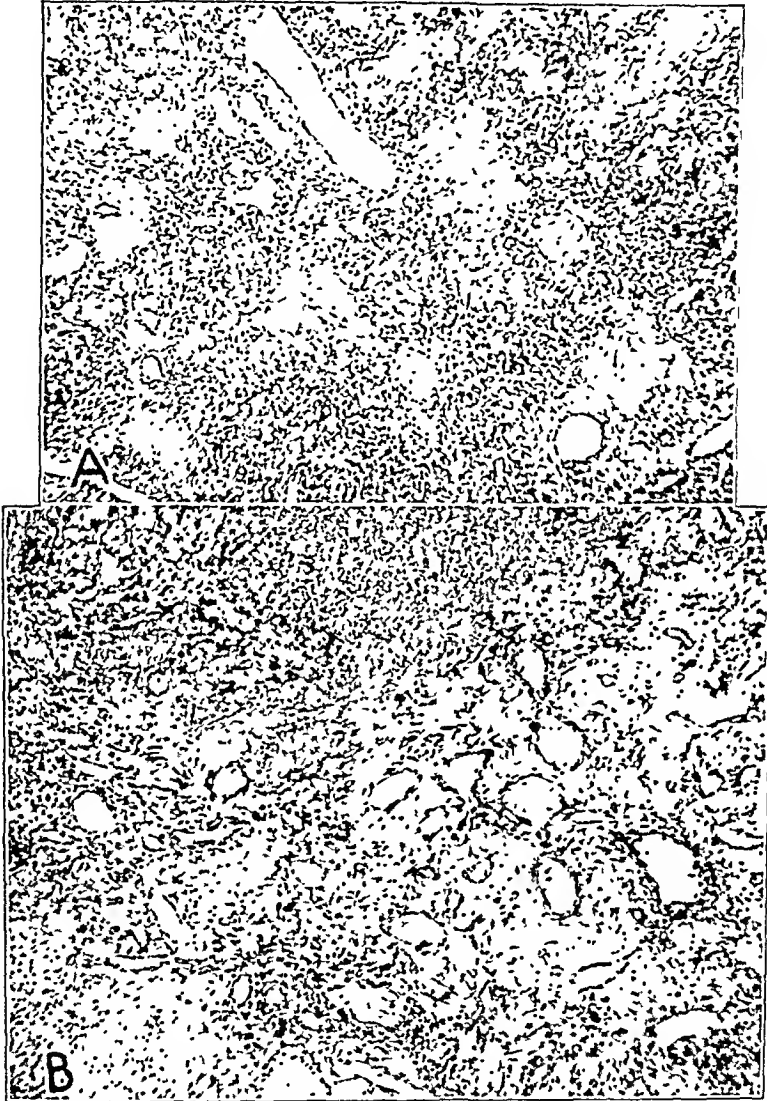
From the Departments of Pathology and Otolaryngology of the Michael Reese Hospital.

1. Schreyer, W.: Der blutende Septumpolyp, *Ztschr. f. Hals-, Nasen- u. Ohrenh.* **16**:41, 1926.

2. Simonetta, B., and Tavani, E.: Sur les rapports entre les "polypes saignants des fosses nasales" et les pseudo-botryo-mycomes, *Rev. de laryng.* **57**:293, 1936.

by cold snare. A small excrescence which developed on the site of the resected polyp disappeared after a course of radium therapy.

*Histologic Examination.*—Microscopic sections of the polyp revealed a structure composed of young connective tissue circumscribed by a layer of stratified squamous epithelium. The latter, in several areas, was interrupted and replaced by fibrin



Granuloma pyogenicum of the nasal fossa. *A*, case 4. Note the dilated blood spaces and the numerous polymorphonuclear leukocytes. Hematoxylin-eosin stain;  $\times 44$ . *B*, case 5. Hematoxylin-eosin stain;  $\times 68$ .

and polymorphonuclear leukocytes. Embedded in the body of the structure within the connective tissue were numerous large and small vascular spaces with endothelial lining as well as many tiny capillaries typical of those seen in granulation tissue. Polymorphonuclear leukocytes were scattered diffusely throughout the sections.

CASE 2.—A boy aged 9 years had had severe attacks of nosebleed for one week. A polypoid structure, about 1.8 cm. in its greatest dimension, was noted on the anterior portion of the left side of the septum. This was resected by the cold snare and the tumor site cauterized with a 20 per cent solution of silver nitrate.

*Histologic Examination.*—The striking feature of the histologic sections was the presence of many large and irregular blood spaces with endothelial lining and with papillary projections of the stroma in the lumens. Some of these spaces were engorged with red blood cells, and others were empty. Elsewhere in the sections were numerous small capillaries typical of granulation tissue. The connective tissue, which was moderately cellular, revealed myxomatous changes and hyaline degeneration. Much interstitial hemorrhage was present, and the tissue was infiltrated with polymorphonuclear leukocytes and mononuclear cells, more densely in the periphery than in the center.

CASE 3.—A woman aged 25 had suffered from repeated attacks of nosebleed. A dark red, easily bleeding polyp attached to the inner surface of the right ala nasi was removed by cold snare.

*Histologic Examination.*—The polyp showed a broad, intact, squamous cell border, with deep projections into the underlying tissue. The connective tissue element, hyalinized in some areas, was predominant. It contained numerous young connective tissue cells, extravasated red blood cells and endothelial lining cells. There were many tiny capillaries as well as arterioles. Polymorphonuclear leukocytes were observed in the superficial parts of the polyp.

CASE 4.—A 35 year old man complained of stuffiness and inability to breathe through the left nostril, from which exuded a serosanguineous discharge. Examination showed a dark pink, moderately firm polyp attached to the anterior portion of the left side of the septum. This growth was resected.

*Histologic Examination.*—Microscopic study of the polyp revealed vascular spaces of various sizes and shapes. The intervening connective tissue was focally edematous. Polymorphonuclear leukocytes and mononuclear cells were present, particularly in the periphery of the structure. In large areas the surrounding squamous epithelium was absent, and in its place was fibrin with inflammatory cells.

CASE 5.—A man presented a dark red polyp, which bled frequently and copiously, on the mucocutaneous junction of the left nostril in the region of the septum. The structure was removed.

*Histologic Examination.*—No epithelial layer was evident. The outer stratum consisted of a layer of fibrin with inflammatory cells in its meshes. Numerous medium-sized and small vascular spaces were observed. The intervening connective tissue was somewhat edematous and contained relatively few fibrocytes. Mononuclear cells and polymorphonuclear leukocytes were observed throughout the section.

#### COMMENT

The prominent inflammatory features of these polyps in the presence of extensive vascularity brings to mind the granuloma pyogenicum, a structure well known to the dermatologist. According to Wile,<sup>3</sup> granuloma pyogenicum is a tumor composed of simple hypertrophic circum-

3. Wile, U. J.: Granuloma Pyogenicum, J. Cutan. Dis. 28:663, 1910.



scribed granulation tissue. Polyps of this type, which are sessile or pedunculated, occur most frequently on the hands (especially about the nails), on the face and lips and in the mouth.<sup>4</sup> They vary from about 0.3 to 2 cm. in greatest dimension and are observed with equal frequency in both sexes and in all age groups. Wile<sup>5</sup> stated:

Clinically the cases [of granuloma pyogenicum] are characterized by rapidly growing lesions, starting definitely in some instances with an injury; at times painful, as often not so, . . . there is marked tendency to recurrence after removal, provided cauterization of the base has not been done. Superficial ulceration occurs in about half the number of cases and where present gives rise to frequent and easily induced hemorrhage. Histologically, too, there is a great uniformity in the findings. In all cases the tumor is one primarily of young connective tissue; in all the presence of blood vessels in greater or less numbers is noticeable. . . . Leucocytic infiltration of the mononuclear and polynuclear variety was present to a greater or less extent in all cases, the latter depending certainly to a degree at least on the presence of superficial ulceration and subsequent infection.

Thus the marked resemblance between the nasal polyps already described (as well as the bleeding polyps of the nasal fossa described in the literature<sup>5</sup>) and the granuloma pyogenicum is evident.

The clinical similarity of these lesions is striking. The growth of lesions of both types is rapid and often painless. Hemorrhage is a usual symptom; bleeding occurs on the slightest contact. Purulent discharge is frequent with both types, and recurrence after removal is likewise a factor common to both. Lesions of both types vary from approximately 0.3 to 2 cm. in diameter. They are bright red, blue-red or brownish red. Both are frequently eroded and may be sessile or pedunculated.

The incidence of bleeding polyps of the nasal fossa resembles that of granuloma pyogenicum. Either may occur in all age groups. It has been stated that bleeding polyps of the nasal fossa have a predilection for females.<sup>6</sup> However, in a series of cases of these polyps chosen at random from the literature, the division was approximately equal between the sexes.

Michelson<sup>7</sup> found a history of minor injury, such as pinprick, in 15 of 29 cases of granuloma pyogenicum of the skin and mouth. It

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4. Montgomery, D. W., and Culver, G. D.: Granuloma Pyogenicum, Arch. Dermat. & Syph. **26**:131 (July) 1932.

5. Pegler, L. H.: The Pathology, Affinities, and Treatment of So-Called Bleeding Polypus (Discrete Angioma) of the Septum, Lancet **2**:1455 and 1537, 1905.

6. Banssillon, M., and Mounier-Kuhn, P.: Sur une forme des épistaxis de la grossesse: Les polypes saignants de la cloison, Bull. Soc. d'obst. et de gynéc. **25**: 71, 1936.

7. Michelson, H. E.: Granuloma Pyogenicum: Clinical and Histological Review of Twenty-Nine Cases, Arch. Dermat. & Syph. **12**:492 (Oct.) 1925.

seems reasonable to believe that trauma might be a factor in the pathogenesis of bleeding polyps of the nasal fossa, particularly in view of the usual location of these polyps in the exposed area of the nose known as Kiesselbach's triangle or the locus of Valsalva. Moreover, it is known that granuloma pyogenicum is radiosensitive.<sup>4</sup> In case 1 of this study the lesion was similarly radiosensitive.

Pyogenic granulomas have been observed in the mucous membrane of the mouth as well as on the skin.<sup>4</sup> In view of their location on the mucous membrane of the mouth, it is probable that pyogenic granulomas may also appear in as closely related tissue as the mucous membrane of the nose. Yet when they occur here they have been classified as bleeding polyps of the nasal fossa.

It may be of interest to mention that a granuloma pyogenicum of the larynx was recently observed in this laboratory.

Histologically the lesions in all 5 cases just reported were identical with bleeding polyps of the nasal fossa reported in the literature (most of which were diagnosed as nasal fibrovascular tumors), as well as with pyogenic granulomas reported in the literature. The granuloma pyogenicum is a structure usually bordered by a layer of epithelium, superficially ulcerated in about one-half the cases. It consists of young connective tissue and young blood vessels. The blood vessels may be so large and numerous as to suggest an angioma. The inflammatory reaction, which consists of infiltration of polymorphonuclear leukocytes and mononuclears, is not invariably present. Michelson<sup>7</sup> stated:

It [the infiltration] is most marked in the upper third of the tumor, especially in eroded lesions. In lesions in which the epithelium is intact, even though thinned, there is often almost complete absence of infiltrate. . . . In certain specimens, there is a line of demarcation between the infiltrative and angiomatous portions of the tumor.

Therefore, bleeding polyps should not be classified as fibrovascular tumors even though their blood vessels present an angiomatous appearance and they do not show diffuse inflammatory infiltration. Apparently, they are pyogenic granulomas.

Cavazzani<sup>8</sup> presented 2 cases of grossly typical bleeding polyps of the nasal fossa which revealed malignant changes on histologic examination. He stated the belief that these malignant changes prove the neoplastic nature of so-called bleeding polyps of the nasal fossa and disprove their relation to pseudobotryomycosis, or granuloma pyogenicum, which Simonetta and Tavani said existed. However, it seems clear that this concept does not hold, since a malignant tumor may arise in a granuloma just as readily as in a benign tumor.

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8. Cavazzani, F.: Sui tumori del naso di origine vascolare, *Oto-rino-laring. ital.* 8:69, 1938.

In view of all that has just been said, it is recommended that the term "bleeding polyp of the nasal fossa" should be discarded. It is inexact and categorical and refers merely to a symptom rather than to the type of underlying lesion. The evidence discussed in this study makes it seem probable that many an easily bleeding, painless, rapidly growing polyp of the nasal fossa, composed of young connective tissue and blood vessels, with or without infiltration of inflammatory cells, is a pyogenic granuloma.

#### SUMMARY

Five cases of bleeding nasal structures diagnosed as granuloma pyogenicum are presented. The identity of bleeding polyps of the nasal fossa with granuloma pyogenicum is shown by comparison of clinical and histologic characteristics of these lesions.

# TREATMENT OF CHRONIC HYPERTROPHIC LARYNGITIS

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Chronic hypertrophic laryngitis occurs often as a result of abuse or misuse of the larynx. Constant trauma, especially in the presence of infection, produces permanent changes in the tissues. The result of this process may take the form of a localized area of inflammation or involvement of the entire membranous cord. In 1934, Loré<sup>1</sup> called attention to the latter type of hypertrophic laryngitis. In addition to observations made in experimental work on animals, he recorded the results obtained in 4 patients by stripping off the mucous membrane of the hypertrophic vocal cord.

The etiologic factor would seem to be trauma to the cords by habitual misuse of the larynx, by repeated acute infection or by a combination of these. In our series of 8 cases one or both of these conditions were present. Three patients worked in a noisy environment in which it was necessary for them to shout in order to be heard. Acute laryngitis combined with abuse of the larynx by constant talking was accountable in 4 cases. Repeated attacks of acute inflammation over a period of years were the responsible factor in 1 case.

By mirror laryngoscopy one observes marked thickening of one or both cords throughout the membranous portion. The posterior cartilaginous portion beginning at the tip of the vocal process of the arytenoid is generally not affected. No interference with motility of the arytenoids can be discerned. The normal pinkish white cord is replaced by a somewhat fusiform, irregular, reddish band which at times appears edematous. If the process is bilateral, the hypertrophic cords commonly are in apposition anteriorly, so that the anterior third of the airway is obliterated (fig. 1). Narrowing of the laryngeal airway sufficient to cause obstructive symptoms seldom occurs. Inflammatory changes may involve the ventricular bands, particularly in their anterior portions.

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From the Department of Laryngology and Bronchology, Jefferson Hospital.

1. Loré, J. M.: (a) Stripping of the Vocal Cords, *Laryngoscope* **44**:803 (Oct.) 1934; (b) Preliminary Report on an Operation for the Relief of Double Abductor Paralysis, *ibid.* **46**:380 (May) 1936; (c) Suggested Operative Procedure for Relief of Stenosis in a Double Abductor Paralysis, *Ann. Otol., Rhin. & Laryng.* **45**:679 (Sept.) 1939.

Generalized laryngeal inflammation, with or without tenacious secretions, is a frequent accompaniment. On phonation, the edematous mucosa acts as a damper on the vibratory motion of the cords and is responsible for the marked dysphonia.

The histologic structure reveals that the chief changes occur beneath the epithelium. The squamous epithelium of the vocal cord becomes thickened with, usually, a layer of keratin on the surface. In the submucosa, edema and fibrosis are striking; associated with this characteristic is an infiltration of chronic inflammatory cells with increased vascularity at times. The tissue beneath the epithelium is increased to two to three times the normal size and is responsible for the thickened appearance of the cord. These changes extend down to the muscle without infiltrating this layer (fig. 2).

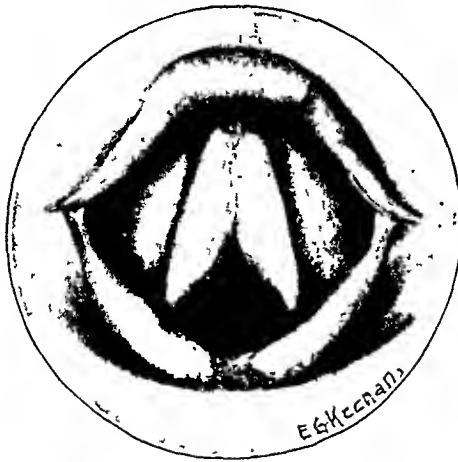


Fig. 1.—Drawing of indirect laryngoscopic view of the larynx in a patient with chronic hypertrophic laryngitis. The hyperplastic and edematous changes involve the entire membranous portion of both vocal cords.

Because of the pathologic alterations, treatment must necessarily be directed toward surgical elimination of the diseased tissue. This procedure is usually limited to restoration of the vocal cords to insure better phonation. If the ventricular bands are also involved no surgical intervention is attempted on these unless they are producing voice disturbances by altering function of the cord. Local medication would have no appreciable effect on the hyperplasia; its only accomplishment would be reduction of inflammation. Regeneration of the cord after removal of the mucous membrane occurs within a short time. Loré has demonstrated that the histologic structure of the new cord is almost identical with that of a normal one.

All operative work can be carried out by direct laryngoscopic manipulation with the area under local anesthesia. Pontocaine hydrochloride (1 per cent) and larocaine hydrochloride (2 per cent) applied

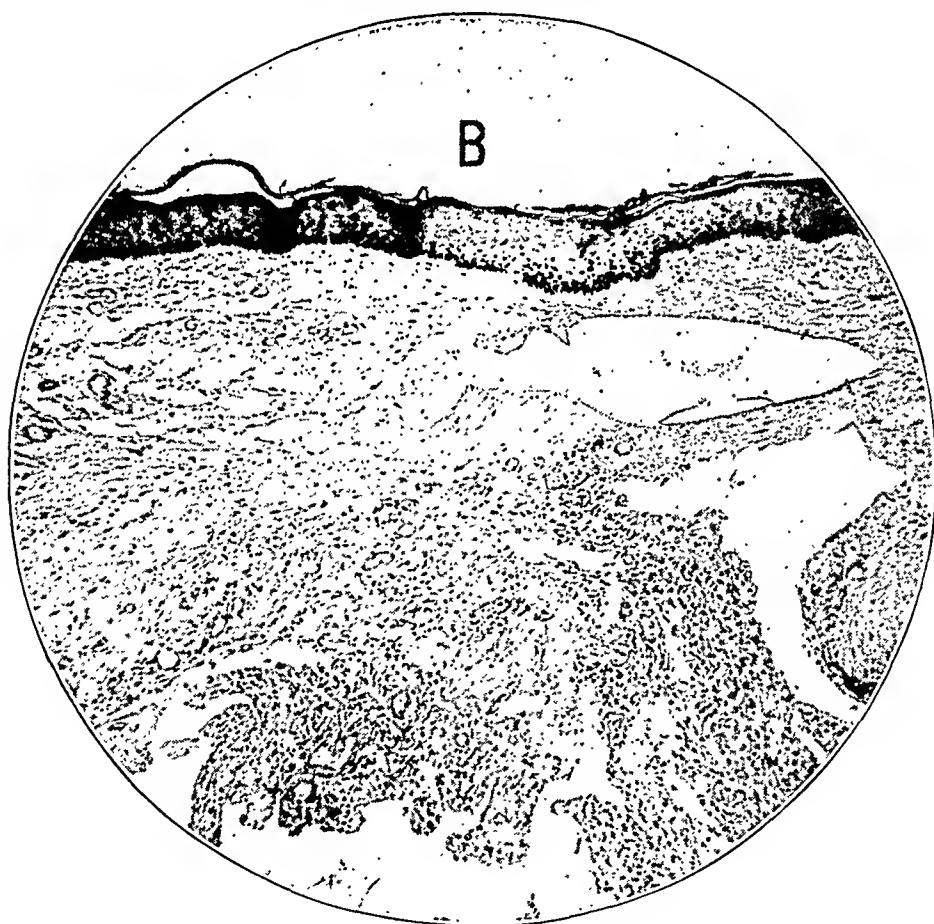
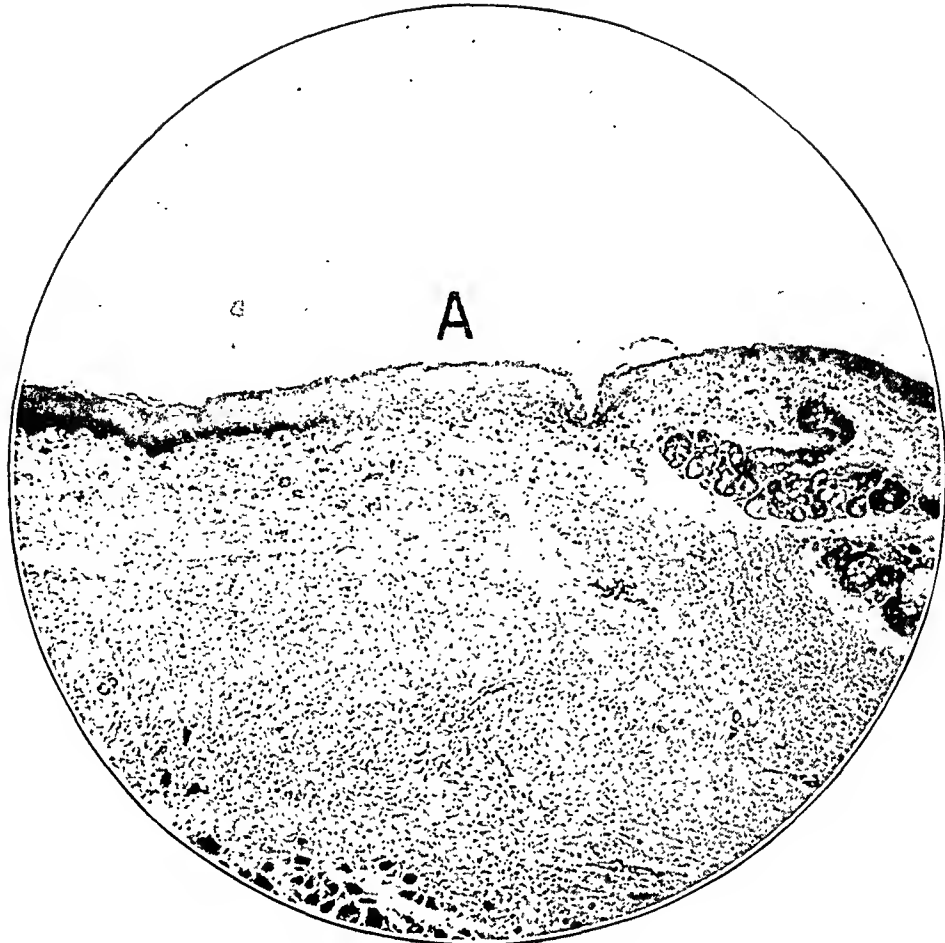


Fig. 2.—Photomicrographs ( $\times 50$ ) (*A*) of normal vocal cord and (*B*) of hyperplastic vocal cord. In *B* the epithelium is thickened, and edema and fibrosis together with infiltration of chronic inflammatory cells appear in the stroma.

to the larynx secure sufficient relaxation and also completely abolish the cough reflex. Removal of the redundant tissue can best be accomplished by the use of straight and bent cupped forceps. The mucous membrane is grasped and traction exerted along the longitudinal axis of the cord; stripping results in a fairly smooth surface. When the tissue is tough and resistant a useful procedure is to cut through the surface with cutting edge or tissue forceps, which allows the mucous membrane to be removed more readily. Both vocal cords can be stripped at the same sitting provided the anterior commissure is not disturbed. The formation of a web must be guarded against, and if there is any question of injury to the anterior commissure only one cord should be stripped at a time. Postoperative vocal rest is maintained for seven to ten days to allow healing and disappearance of exudation before the beginning of motion.

The following case reports will serve to illustrate the findings in chronic hypertrophic laryngitis, with either unilateral or bilateral involvement.

#### REPORT OF CASES

CASE 1.—A ship fitter 50 years of age, was admitted to the hospital complaining of hoarseness for eight years. The patient found it necessary to employ his voice constantly in a noisy environment and, in addition, smoked excessively and used alcohol in moderation. His continued shouting produced huskiness, which later developed into definite hoarseness. Mirror laryngoscopy disclosed generalized inflammation. The left vocal cord was edematous, and there was marked mucosal redundancy along its free margin; the middle portion of the right cord was replaced by a sessile, boggy lesion. Direct laryngoscopic exposure with the area under local anesthesia made it possible to strip the mucous membrane from the entire left cord and from the involved portion of the right. The histologic report of the tissue removed was that the condition was a chronic inflammatory lesion of the larynx. Considerable reaction and exudation resulted, but after these had subsided the edges of the vocal cords were straight and the voice was restored.

CASE 2.—A 42 year old housewife was referred to the bronchoscopic clinic because of persistent hoarseness for the past year. At the onset of the voice disturbance the patient contracted an acute infection of the upper respiratory tract. After this had abated an irritative cough and hoarseness appeared; repeated infections aggravated these symptoms. Alcohol and tobacco were used in excess. Studies of the lungs and blood gave negative results. Mirror examination revealed that the entire membranous portion of the left vocal cord was swollen, and its inner edge presented a somewhat edematous appearance. The right vocal cord appeared normal except for chronic congestive changes. The motility was normal, and no ulceration was observed. The mucosa of the left cord was stripped off under direct laryngoscopic visualization; local anesthesia was used. The lesion was diagnosed histologically as a fibroangioma. Vocal rest was advised for a week. After vocalization was resumed the voice steadily improved, and the examination demonstrated a thickened cord with a straight edge.

The following table indicates the essential features of this group of cases. Only patients with diffuse involvement of the entire membranous cord are included.

*Data on Eight Patients with Chronic Hypertrophic Laryngitis*

Case	Sex	Age (Yr.)	Duration	Site of Lesion	Method of Treatment	Result
1	M	50	8 yr.	Both cords	Stripping of mucous membrane	Cord edges straight; voice normal
2	F	42	1 yr.	Left cord	Stripping of mucous membrane	Cord slightly thickened; edge straight; voice slightly husky
3	M	40	1 yr.	Right cord	Removal of redundant mucous membrane	Slight irregularity of cord edges but voice satisfactory
4	M	63	5 yr.	Both cords	Removal of redundant mucous membrane	Cord edges straight; voice improved
5	F	48	7 yr.	Right cord	Incision and stripping off of mucous membrane	Some congestion of right cord; voice normal
6	M	57	6 wk.	Both cords	Right cord stripped first; left cord stripped after one month	Cord edges straight but somewhat thickened; voice normal
7	M	50	6 mo.	Both cords	Incision and stripping of mucous membrane	Left cord still thickened; voice improved
8	M	41	2 yr.	Both cords	Stripping of one cord followed later by same procedure on opposite side	Thickened right cord; voice improved

#### SUMMARY

Surgical stripping of the mucosa of the vocal cords secured satisfactory anatomic and functional results in 8 cases of chronic hypertrophic laryngitis. Although the group of cases was not large, this condition is infrequent. The pathologic changes in this disease are hypertrophy and hyperplasia, and surgical extirpation must be performed to effect a cure. Stripping of the cordal mucous membrane in cases of hypertrophic laryngitis associated with diffuse edematous involvement of the entire membranous cord seems the best method of bringing about restoration of the voice and return of cord function.



# THE CANINE FOSSA

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The canine fossa constitutes the chief part of the anterior, or facial, surface of the maxilla. It extends from the infraorbital margin above to the alveolar process below, and horizontally from the zygomatico-maxillary suture to the anterior nasal aperture.

From a study of 200 skulls and many wet specimens it is found that there is a great variation in its construction, an understanding of which will aid greatly in the performance of certain surgical procedures which involve this area, particularly the Caldwell-Luc and the Denker operation.

## STRUCTURE

The distance from the alveolar process above the second bicuspid tooth to the infraorbital margin was found to range between 30 and 49 mm., the average being 39.2 mm. (fig. 1). With the loss of teeth there are absorption of the alveolar process and a recession of the floor of the antrum reducing the height of the front wall until there is left little room for a surgical procedure. In one specimen, in which the change had occurred gradually over a period of more than fifty years, this height had been reduced to 14 mm. without the floor of the sinus being exposed. It is interesting to note that the height of this surface at birth is about 12 mm.

The lateral boundary is marked by the suture between the maxillary and the malar bone, which is approximately in a vertical plane continued downward from the lateral orbital margin. The sinus may extend beyond this suture, being limited laterally by the limit of the malar bone. Mesially the anterior wall extends to the nasoastral wall, at the junction of which there is formed the Y described by Ennis and Batson.<sup>1</sup> This angle may be completely pneumatized, in the event of which the sinus

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From the Department of Anatomy of the University of Southern California School of Medicine, with additional material from the Santa Barbara Museum of Natural History.

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Mr. A. B. Streedain prepared the illustrations, and the contributions of the Research Study Club of Los Angeles to the Anatomy Research Fund aided in this study.

1. Ennis, L. M., and Batson, O.: Variations of the Maxillary Sinus as Seen in the Roentgenogram, *J. Am. Dent. A.* **23**:201 (Feb.) 1936.

is brought to the forward limit of the nasal aperture; in such a case the Denker operation could easily be accomplished. On the other hand, the junction of these two walls may be as much as 20 mm. from the anterior border of the piriform space, all of which would have to be removed in the Denker procedure. It should also be noted that in such

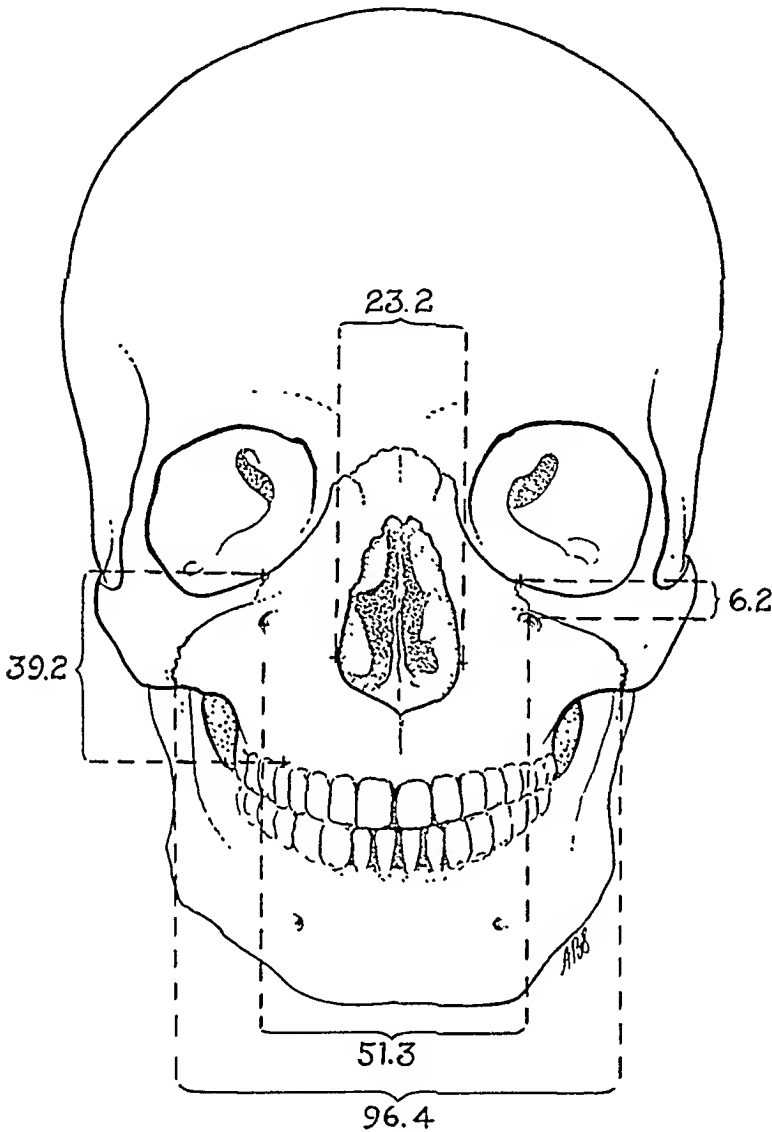


Fig. 1.—Front view of a skull, showing various measurements (in millimeters) pertaining to the canine fossa, based on 170 adult specimens: widest part of the anterior nasal aperture, 23.2 mm.; between the infraorbital foramina, from center to center, 51.3 mm.; from the infraorbital margin to the upper margin of the infraorbital foramen, 6.2 mm.; greatest width of the maxilla at the zygomaticomaxillary suture, 96.4 mm., and from the infraorbital margin to the alveolar process at the second bicuspid tooth, 39.2 mm.

an instance a trocar passed through the inferior meatus might miss the antrum entirely and enter the soft tissues in the canine fossa.

The infraorbital foramen is situated at the junction of the middle and inner one third of the infraorbital margin in a horizontal plane

which is often on a level with the anterior attachment of the inferior turbinate. In other words, a line drawn between the point of attachment of the inferior turbinate bones extended laterally will in many instances be on a level with the infraorbital foramens.

In a series of 170 specimens the average distance of the foramen below the orbital margin was found to be 6.2 mm., varying between 2 and 13 mm., the position being determined largely by the growth of the nerve in relation to the osseous development.

Early in embryonic life the infraorbital nerve is on the upper surface of the membranous mass, which ossifies to form the future maxilla. If the two develop at about the same rate, the nerve will remain on the surface in a shallow sulcus except at the orbital margin, where the bone usually develops around it to form a short canal which opens on the face immediately below the orbital margin. On the other hand, the facial end of the nerve may become fixed and the bone envelop the nerve in such a manner as to form a canal the full extent of the nerve; the facial end of the canal would be deeply embedded in the upper forward angle of the maxilla and would lie at a considerable distance from the roof of the antrum as pneumatization is completed.

Thus the foramen may be some distance below the infraorbital margin, with the canal projecting upward and outward following the curvature of the maxilla. However, the canal posterior to the orbital border usually runs parallel to the midline at a distance of about 25 mm. This arrangement causes the size of the foramen and the direction of the canal to vary over a wide range, even on the two sides of the same person, and explains the difficulty occasionally encountered in attempting to enter the canal with a needle for effecting local anesthesia.

The lower mesial part of the foramen is widened and beveled, directing the needle into the canal, but the upper, outer portion presents a shelf or ledge formed by bony growth over the nerve. If the ledge is marked the opening will be directed downward and mesially and can be entered only by a curved needle directed upward and outward below the ledge. The quadratus labii superioris muscle is attached above the foramen, where a marked tubercle is often present which may be palpated during life.

The infraorbital foramen gives exit to the cutaneous branches of the infraorbital nerve, which is the terminal branch of the maxillary nerve, the second division of the trigeminus (fig. 2). These cutaneous branches supply sensory fibers to the skin and soft tissues about the upper lip, cheek, nose and lower eyelid. Some fibers enter the bone to supply the periosteum and may join the alveolar plexus. Occasionally there are one or two accessory openings mesial to the foramen for the palpebral and the lateral nasal branch. The anterior and the middle branch of the superior alveolar nerve are given off on the lateral side

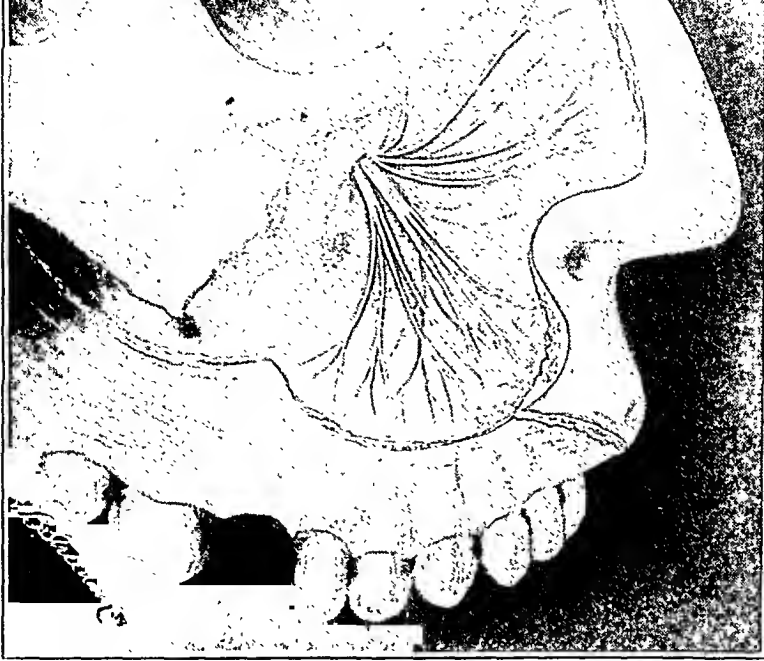


Fig. 2.—Right side of the face, showing the terminal branches of the infraorbital nerve which are distributed to the soft parts. When the canine fossa is exposed surgically it may be noted that a vertical incision carried to the bone from above downward would sever many of these branches near the foramen, thus giving rise to a more pronounced and extended disturbance in sensation than would the traditional horizontal incision. These filaments do not supply the teeth, but may reach the alveolar process to anastomose with some of the terminal branches of the alveolar nerves.



Fig. 3.—Right view of an edentulous maxilla with transmitted light, showing the alveolar nerves in their course across the front wall of the maxillary sinus. They run in small canals within the bony substance. The anterior and the middle branch of the superior alveolar nerve are plainly seen, as well as the alveolar plexus. It is to be noted that on entering the antrum by way of the canine fossa a surgeon would sever both trunks. Accompanying the nerves in their osseous canals are small arteries which are passing toward the teeth and interruption of which is a real danger to the vitality of the teeth. In this specimen the nerves and blood vessels to the soft tissues have been cut at the foramen.

of the main trunk at some point behind the infraorbital foramen and continue downward in small canals within the thin bony wall (fig. 3). If they run near the surface they will be found on the inner wall in small grooves, and for this reason the lining membrane of the sinus should be gently elevated and removed, rather than curetted. The anterior branch of the superior alveolar nerve is directed downward and mesially below the infraorbital foramen, where it is at times exposed for a short distance on the facial surface of the bone and might be severed in the making of a vertical incision if the incision were carried to the bone at this point.

#### SURGICAL APPLICATION OF KNOWLEDGE OF THE STRUCTURE

*Selection of Patients and Technics.*—When one is convinced that a surgical procedure is inevitable or is necessary to bring about a cure, he should proceed to determine the type of operation best suited for the patient, the object being not only to relieve the symptoms present but to be certain that a more distressing situation is not created. The technic selected should then be designed to remove the pathologic condition with a minimum of trauma to surrounding tissues. It is my conviction that a surgical intervention on a sinus if indicated, should be complete in one sitting; temporizing operations have a tendency to aggravate the condition rather than to effect a permanent cure. In order to bring about these objectives one must visualize the operation, which in a case of involvement of the maxillary sinus is best accomplished through the canine fossa. The ease with which a Caldwell-Luc or a Denker operation may be accomplished depends on the depth of the canine fossa and the forward extension of the sinus in the nasal process. Lateral and intraoral roentgenograms will help determine the extent of pneumatization in this region and should be carefully studied before a surgical procedure is attempted. A thin, narrow face would indicate a deep canine fossa, and therefore one on which operation is more difficult; it would necessitate the removal of a great amount of bone to complete the Denker technic.

*Preparation of the Patient.*—The patient should have complete confidence in the surgeon, and his mind should be at perfect ease. The object and the essential steps of the operation should be explained and above all the possible after-effects. After a Caldwell-Luc or a Denker operation there is more or less anesthesia of the incisor teeth, which may also involve the cuspid and bicuspid teeth if the middle branch of the superior alveolar nerve is in the surgical field. The disturbance in sensation is usually temporary but may be permanent. The annoyance is greatly minimized if the patient is aware of the possibility beforehand.

Operations through the canine fossa are usually best accomplished with the region under local anesthesia, which necessitates injection of

the anesthetic into the infraorbital nerve in the canal. Since the foramen is deep in the fossa, usually facing the central incisor of the opposite side, a needle with a gentle curve is inserted to the bottom of the fossa in an upward and outward direction; the bevel of the needle should be toward the bone, for this facilitates entrance. One may with the point of the needle feel the overhanging ledge just above the foramen.

*Incision.*—In the literature for many years there have appeared from time to time discussions as to the relative merits of the longitudinal and of the vertical incision, particularly with regard to the disturbance of sensation to the teeth. Advocates of the vertical incision contend that less damage to the nerves follows that incision as it is in the direction of the nerve fibers. They lose sight of the fact that the alveolar nerves, the source of sensation to the teeth, travel in canals within the bony wall which are often running in a direction at a right angle to such an incision and might be injured in instances in which there is a dehiscence in the canal if the incision is carried to the bone at this point. The terminal portion of the infraorbital nerve, which is distributed to the soft tissues, spreads out at the foramen in a fan-shaped group of branches, many of which would be in the line of a vertical incision. Since adequate exposure is necessary to good surgical procedure and in view of the fact that a cleancut wound produces less reaction than do tissues torn and bruised by retractors, it would seem that perhaps a combination of the two types of incision, as suggested by Ziegelman,<sup>2</sup> offers the best possible exposure with a minimum of trauma. A vertical incision through the mucosa down to the usual horizontal incision allows for adequate exposure with little traction; the periosteum being elevated from below upward, the vertical incision is extended as one proceeds.

*Surgical Window.*—An opening of sufficient size to accomplish the desired result must be made through the front wall of the sinus. The alveolar nerves and blood vessels run in tiny canals within the bony wall and cannot be pushed aside. The amount of damage to the sensation and vitality of the teeth depends on whether the nerves and blood vessels are in the field of operation. The position and arrangement of the nerves and vessels are so variable that one is unable to foretell the extent of disturbance which may follow a surgical procedure in this area. Some specimens show such a network of canals that an opening could not be made without considerable damage to them; while in others there is ample room, and the canals might be avoided if one could only locate them. For this purpose a small light placed in the antrum through an opening in the nasoantral wall under the inferior turbinate bone is of great value; this is inserted after the canine fossa has been exposed,

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2. Ziegelman, E. F.: The Inverted T Shaped Incision with Block Anesthesia in Radical Surgery of the Maxillary Sinus, West. J. Surg. **42**:103 (Feb.) 1934.

before the opening in the bone is made (fig. 4). The anterior superior alveolar canal will be seen to extend from a point lateral to the infra-orbital foramen diagonally downward and mesially toward the incisor teeth, while the middle branch of the superior alveolar canal will take a course downward and somewhat laterally toward the canine and the bicuspid teeth. It will thus be seen that the danger of injury to the nerves increases as the infraorbital foramen is approached. Therefore, the location of the foramen determines the possible area that may be removed. In general, it may be said that the farther the foramen is removed from the orbital margin, the more it encroaches on the surgical field.



Fig. 4.—Drawing made from a specimen similar to the one used in the preparation of figure 3. The nerves and blood vessels to the soft tissues have been removed. The figure shows the posterior branch of the superior alveolar nerve running forward to connect with the middle and the anterior branch to form the superior alveolar plexus. It will be noted that the main alveolar trunk could be avoided in the event of surgical intervention through this fossa, if the surgeon could only visualize it.

It must be remembered that the vitality of the teeth is dependent not so much on the nerve supply but on the blood supply, which reaches them through small canals in the bone. Therefore, the bone near the roots of the teeth should not be removed.

#### SUMMARY

1. The nerve and the blood supply reach the teeth through small canals within the thin bony wall of the antrum. The arrangement is so variable that one cannot foretell the extent of possible disturbance in function after an operation through the canine fossa.

2. The direction of the incision through the soft tissues bears no relation to the disturbance of sensation in the teeth.

3. Transmitted light is of value in the locating of the alveolar canals as they cross the canine fossa.

4. The inverted T-shaped incision suggested by Ziegelman offers good exposure with a minimum of traction.

5. The infraorbital foramina are situated at variable distances below the infraorbital margin but are usually on a level with the attachment of the anterior end of the inferior turbinate bones. The opening is often directed toward the central incisor of the opposite side, a point to remember in attempting to make an injection into the canal.

6. The depth of the canine fossa has a definite bearing on the ease with which one may perform the Caldwell-Luc or the Denker operation.



# PSEUDOXANTHOMATOUS TUMOR OF THE MASTOID

## RÉSUMÉ OF LIPOIDOSES

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In recent years an unusual and interesting case came to my attention. After careful biopsies of tissue obtained on two different occasions, a tentative diagnosis of hemangioblastoma with pseudoxanthomatous change was made. The patient's history, the findings at operation and the results of microscopic study led to this conclusion, after a careful review of the more recent journals and available pathologic texts.

### REPORT OF A CASE

A white youth aged 19 was admitted to the Robert Long Hospital on Nov. 15, 1935, with the complaints of (1) deafness in the right ear for about two years, (2) some discharge from that ear for one year but none in the past year and (3) paralysis of the right facial nerve for four months after noting of pain shooting down into the neck on the same side for a time.

The patient's own past history as well as his family history proved essentially noninformative, except that he had always contracted frequent colds.

*Physical Examination.*—The patient was a tall, asthenic and anemic white man with paralysis of the right facial nerve, dental caries and a tumor mass practically filling the right external auditory canal. A reduced gag reflex was obtained on the right. An inconstant rotatory nystagmus was noted when the patient looked to the right and sometimes when he looked to the left. There was hypesthesia of the right cornea and of the nasopharynx. A drooping right shoulder appeared as due to atrophic changes in the right trapezius and the sternocleidomastoid muscle. A negative Rinne reaction was elicited on the right, and the Weber test revealed lateralization to the right. Bone conduction on the right side was present but decreased. Laryngoscopic examination showed the right cord in the cadaveric position. Spinal puncture yielded fluid under a pressure of 16 millimeters of mercury; there was no change in pressure on application of the Queckenstedt test on the right.

*Treatment and Progress.*—An attempt on Nov. 27, 1935 to take a specimen for biopsy proved unsuccessful, owing to excessive bleeding. A satisfactory specimen was obtained at a later date, after six roentgen treatments of 200 r each. After a series of ten more such roentgen treatments, the patient was operated on, Feb. 12, 1936, and as much tumor as possible was removed from the right

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mastoid. The posterior wall of the external canal was eroded by the growth, and a portion of the petrous process was definitely involved. Complete removal of the tumor tissue was impossible, and the resultant uncontrollable hemorrhage demanded a ligation of the right carotid artery. Transfusions followed the operation. During an uneventful convalescence the patient received four roentgen treatments of 285 r each. The surgical incisions healed well, and roentgenographic check-up on the long bones revealed no malignant growth on April 24, 1937. Further check-up, on Oct. 29, 1938, showed the chest, long bones and skull to be normal except that the petrous ridge on the side which had been operated on appeared thinned. However, there was no evidence of any pathologic process in the area. Only residual paralysis of the seventh nerve and moderate deafness in the right ear remained.

*Laboratory Findings.*—Specimens of the spinal fluid were normal. The blood cholesterol readings were 47 and 58 mg. per hundred cubic centimeters, and the basal metabolic rates on three occasions were —12, —19 and —15, respectively. Roentgenographic examination of the right mastoid showed haziness of both the mastoid and the external auditory canal. The petrous tip on the right showed some destruction. Both antrums and frontal bones appeared to be involved to some extent.

The biopsy report by Dr. C. G. Culbertson, pathologist, Indiana University Medical Center, read as follows:

Gross Observations: "The specimen consists of several small pieces of soft tissue and bone. The bony tissue is decalcified, and the soft parts sectioned are without decalcification."

Microscopic Observations: "Study of the many small pieces removed shows some rather dense bone with some evidence of rearrangement of its structure. Many pieces are present which do not show any pathologic process. One or two areas show a very vascular type of tissue apparently proliferating inside the bone, causing apparent atrophy of the bony trabeculae. On further study this is seen as an unusual type of tissue which is the combination of small and large blood channels between which are situated masses of a somewhat indistinct type of cell apparently resting in areas of fibrous tissue. Some of the larger cells contain small vacuoles, and many vacuoles of fat are seen in the connective tissue. The predominating histologic picture is doubtless the multiple blood channels, which in itself suggests a hemangioma. Study of the endothelium of these blood vessels shows it quite distinct, and in some areas it is suggested that the small irregular masses of indistinct cells may have been derived from proliferation of the capillary endothelium. Study of the soft tissue removed reveals a variety of tissue, some areas showing a fibrous structure containing blood channels and nests of these same indistinct masses."

Tentative Diagnosis: "Hemangioblastoma showing pseudoxanthomatous change."

#### COMMENT

In substantiation of Dr. Culbertson's assumption I quote Penfield<sup>1</sup> on hemangioblastoma found as a primary tumor of the central nervous system:

This tumor occurs most frequently as a nodule in the wall of cysts of the cerebellum. Unless a careful search is made for the mural nodule a diagnosis is

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1. Penfield, W.: *Cytology and Cellular Pathology of the Nervous System*, New York, Paul B. Hoeber, Inc., 1932, vol. 3, pp. 942-945.

apt to be given of gliomatous cyst. Similar tumors also develop as solid nodules, especially at the posterior extremity of the fourth ventricle and in the spinal cord. They are often associated with angiomas of the retinae and with various peripheral lesions such as cystic pancreas, cystic kidney, cavernoma of the liver, etc., to form a pathological complex now known as Lindau's disease (1926).

The tumors in the central nervous system consist essentially of a myriad of capillary spaces, but by proliferation of the endothelium a more solid tissue may be produced (hemangio-endothelioma) or by dilatation of the capillary spaces a cavernous structure may result.

The variant most apt to be confused with a glioma is the solid endotheliomatous type. . . . It can usually be distinguished by the network of reticulum which permeates the tumor between the cells, or by the fact that the neoplastic cells are filled with lipoidal granules to form what are known as "pseudo-xanthomatous" cells. . . .

One of the best reviews concerning hemangioblastomas is found in the book "Tumors Arising from the Blood Vessels of the Brain."<sup>2</sup> This work proposed the idea that these tumors arise from vasoformative cells and that the resultant hemangioblastomas may vary from a cystic to a solid tumor and may have any degree of vascularity. Therefore, the macroscopic picture tends to differ considerably, even though microscopically an intimate relation is observed. In regard to angioblastic formations in the cerebellum, a common site for the anomaly, a greater number are found to be cystic, with perhaps only a small mural nodule of tumor tissue present. Judging from the series of cases reported in this book, its authors concluded that the tumors "pass by gradations from the simple capillary form of tumor to the cavernous and the cellular forms, and that no tumor is, architecturally speaking, pure in type."

The removal of these growths may require only a simple enucleation, whereas, on the other hand, much difficulty may be encountered. Along this line Cushing<sup>3</sup> stated:

The tumors may be associated with such a formidable degree of vascularity the attempt even to take tissue for verification would be regarded as foolhardy. It is in these truly desperate cases that electro-desiccating procedures may prove most helpful, but at best the surgical removal of one of these tumors is attended with the greatest possible hazard.

The histologic descriptions given by the authorities just referred to compare well with the microscopic observations which in my case prompted the diagnosis of hemangioblastoma with pseudoxanthomatous change.

#### REVIEW OF LIPOIDOSES

A review of the literature while I was studying this case led me into the bewildering field concerned with xanthomatous pathology and its

2. Cushing, H., and Bailey, P.: *Tumors Arising from the Blood Vessels of the Brain*, Springfield, Ill., Charles C. Thomas, Publisher, 1928.

3. Cushing, H.: *Intracranial Tumors*, Springfield, Ill., Charles C. Thomas, Publisher, 1932, p. 123.

numerous aspects. It seems pertinent, therefore, to outline briefly present day thought on this subject, particularly as it affects the otolaryngologist.

The term "lipoidoses" seems most suitable as a heading for this group of pathologic entities, which includes such extremes as xanthelasma and the Hand-Schüller-Christian syndrome. It is generally agreed that the disturbed lipid metabolism is at least one characteristic all these conditions have in common. The word syndrome is used because such conditions are actually symptom complexes rather than disease by definition.

*Xanthoma Tuberosum*.—Following the classification proposed by L. Pick,<sup>4</sup> one can consider first the localized forms of lipoidoses, which seemingly may or may not be neoplastic. Typically, microscopic examination shows a few foam cells in intimate relation with the adventitia of small blood vessels situated subcutaneously or under mucous membranes.<sup>5</sup> Later the cells tend to enlarge, and coalescence of some gives rise to Teuton giant cells. Foreign body giant cells may also be present. Connective tissue cells are particularly prone to fatty degeneration.

Histologic study leads to the consideration of plausible etiologic factors. Trauma (particularly when long continued), hereditary factors, inflammatory processes, deficiency diseases, jaundice and numerous other conditions seem to play a part at times. It is fairly generally believed that the phagocytosing cells of the reticuloendothelial system give rise to the foam cells, and yet the fundamental reason for this cannot be ascertained. The color of the nodules is thought to be due to a combination of carotenoid pigments with cholesterol esters. Cause will again be touched in the discussion of each other form of lipoidoses to be described, but in no instance will the discussion be any farther beyond the hypothetic stage than in the case of the comparatively simple xanthoma.

Localized xanthomatous nodules are usually multiple; however, certain sites have been reported that are of particular importance to the otolaryngologist. Besides those records in the literature of xanthoma tuberosum on the neck,<sup>6</sup> on the eyelid (these xanthelasmas being the most frequent form of xanthoma), on the tendon sheaths<sup>7</sup> and in other

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4. Pick, L.: A Classification of Diseases of Lipoid Metabolism and Gaucher's Disease, *Am. J. M. Sc.* **185**:453-469 (April) 1933.

5. Plewes, L. W.: Nature and Origin of Xanthoma Cell, *Arch. Path.* **17**: 177-186 (Feb.) 1934.

6. Humiston, C. E., and Piette, E. C.: Xanthoma of Neck, *Ann. Surg.* **88**: 124-128 (July) 1928. Charache, H.: Congenital Xanthoma Tuberosum, *Am. J. Cancer* **31**:563-566 (Dec.) 1937.

7. Gomori, G.: Uncommon Tumor (Xanthoma of Tendon Sheath), *Am. J. Surg.* **33**:150-156 (July) 1936.

locations, the reports of more interest show involvement of the pharynx<sup>8</sup> and the larynx<sup>9</sup> and, in some of the cases of laryngeal involvement, the trachea. Laryngeal damage may be extensive and is another possible cause of hoarseness. The degree of damage in some of these cases necessitated tracheotomy before other therapeutic measures could be considered. The distortion of the tissue involved results largely from the fibrosis which is apt to follow the initial inflammatory and tumorous processes.

Xanthomatous tumors have also been reported recently in relation with the external auditory canal<sup>10</sup> and with the mastoid process.<sup>11</sup> In the case of the latter condition both mastoid processes were extensively involved, and there was erosion of the dural plates as well as extension into the antrum and labyrinth. Consequently the removal of all tumor tissue was out of the question. The patient, just before her death because of terminal pneumonia, began to show numerous bony defects in the skull, two defects in the right tibia, larger mastoid lesions and defects in the seventh rib bilaterally. These findings warranted the conclusion that this condition belonged in the Schüller-Christian group. In this case, as in many of these cases, it is impossible to make a clear-cut diagnosis as to whether the condition should be considered as xanthomatosis or as the Hand-Schüller-Christian syndrome. Treatment in this case consisted of roentgen therapy, transfusions and administration of solution of posterior pituitary thyroid, liver extract and vitamins, together with other measures, to no avail.

Treatment for these tumors is best discussed in the following section, on xanthomatosis. Fortunately xanthomas usually are benign, although they are prone to recur and may give rise occasionally to sarcomatous changes or, less frequently, to the development of carcinoma.

*Xanthomatosis.*—Coming to the generalized forms of lipoidoses, one must at least mention the symptomatic, or secondary, forms, in which the manifestations of disturbance in lipid metabolism accompany such

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8. Pollock, H. L.: Head and Neck Manifestations (of Xanthoma) in Metabolic Disorders, *Ann. Otol., Rhin. & Laryng.* **43**:553-560 (June) 1934.

9. Schatz, H. A.: Xanthoma of Larynx, *Laryngoscope* **40**:300-301 (April) 1930. Finney, W. P.; Montgomery, H., and New, G. B.: Xanthoma Multiplex: Two Cases Involving Larynx and Trachea, and Associated with Diabetes Insipidus, *J. A. M. A.* **99**:1071-1074 (Sept. 24) 1932. New, G. B.: Xanthoma of Pharynx and Larynx, *Arch. Otolaryng.* **22**:449-453 (Oct.) 1935. Weidman, F. D., and Schaffer, H. W.: Xanthoma of Skin and Larynx Associated with Carcinoma of Stomach and Regressive Xanthoma of Pons, *Arch. Dermat. & Syph.* **35**:767-814 (May) 1937.

10. Rosenberger, H. C.: Solitary Xanthoma of External Auditory Canal, *Arch. Otolaryng.* **26**:395-399 (Oct.) 1937.

11. Wood, V. V.: Bilateral Xanthomatosis (Lipoidosis) of Mastoid: Case, *Ann. Otol., Rhin. & Laryng.* **46**:991-1008 (Dec.) 1937.

diseases as diabetes, chronic hepatic disease and jaundice. The resultant yellow or brown nodules usually appear on the extensor surfaces and almost invariably show surrounding inflammatory manifestations when associated with diabetes.

The essential, or primary, forms, resulting from some underlying constitutional anomaly of lipid metabolism, include the so-called xanthomatoses. These might be called lipid histiocytosis or lipid granulomatosis.<sup>12</sup> To explain why such generalized primary xanthomatosis collections develop, Rowland<sup>13</sup> and others have suggested that lipoids in excess irritate vessel walls, causing them to produce some infiltration of perivascular cells and some degeneration. The lesions then result from the phagocytic action of the reticuloendothelial system. Other workers<sup>14</sup> have proposed that there is an underlying intracellular disturbance in the reticuloendothelial cells themselves which brings about the production of xanthoma cells with or without an accompanying lipemia. This theory tends to explain why only certain sites in the body are involved. The fact that many patients fail to show an appreciable hypercholesteremia discounts the hypothesis that the increase in cholesterol is the causative factor. Therefore, the idea of a lipid imbalance between certain cells and the blood stream or of a disturbance in lipid metabolism, either locally or generally, seems the most plausible theory, even though a patient may show either of these in some other condition without the appearance of xanthomatosis. Controversy over the etiologic factors enumerated has prompted Sugg and Stetson<sup>15</sup> to raise the following question: In this case (one of xanthomatosis) "are we dealing with a simple disease of the skin due to some unknown metabolic disturbance, or is this a mild form of some grave constitutional disease?"

Patients with this condition may or may not show involvement of the mucous membrane. External lesions are more apt to be found on flexor surfaces, and these frequently send the patient to his doctor. There may be an accompanying diabetes insipidus. The amount of blood cholesterol is, as a rule, not elevated, although a definite increase

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12. Smith, L. A.: Xanthomatosis Involving Bone: Case Reports and Roentgen Findings, *Radiology* **24**:521-534 (May) 1935.

13. Rowland, R. S.: Xanthomatosis and the Reticulo-Endothelial System: Correlation of Unidentified Group of Cases Described as Defects in Membranous Bones, Exophthalmos and Diabetes Insipidus, *Arch. Int. Med.* **42**:611-674 (Nov.) 1928.

14. Thannhauser, S. J., and Magendantz, H.: The Different Clinical Groups of Xanthomatous Diseases: A Clinical and Physiological Study of Twenty-Two Cases, *Ann. Int. Med.* **11**:1662-1746 (March) 1938.

15. Sugg, E. S., and Stetson, D. D.: Xanthoma Tuberosum Associated with Trauma and Mild Diabetes Mellitus, *J. A. M. A.* **108**:414-417 (Aug. 7) 1937.

in tissue cholesterol has been shown.<sup>16</sup> Treatment consists chiefly in low fat diet, roentgen therapy, general supportive care and excision of any nodules as indicated.

*Hand-Schüller-Christian Syndrome.*—This syndrome appears about as well established as any of those included in this general group. One case in which the condition involved particularly the mastoids has previously been mentioned. For some unknown reason in the affected patient (more often male) cholesterol and its esters<sup>17</sup> are abnormally stored and a characteristically granulomatous tissue is produced in the involved areas.

Characteristic findings are: (1) irregular osseous defects (particularly of the skull) of moth-eaten appearance; (2) exophthalmos; (3) diabetes insipidus; (4) retarded skeletal growth; (5) cholesteremia; (6) gingivitis,<sup>18</sup> and (7) loss of teeth due to deposition of fat in the apices.<sup>8</sup> Dyspnea, cyanosis, splenohepatomegaly, lymphadenopathy and yellowish brown discoloration of the skin are also possible. The amount of general deposition of lipoid is usually less marked than in the Niemann-Pick syndrome. Aural manifestations, such as pain, dizziness and functional loss of hearing, are apt to appear, because the temporal and parietal bones are most frequently involved. The lateral sinus, dura, middle ear, labyrinth and petrous pyramid have been attacked.<sup>19</sup> The exophthalmos is due to orbital softening.

Remissions are the rule, more so if the condition is treated. However, the syndrome rarely permits an afflicted person to live beyond the third decade. Treatment at present includes a low fat and low cholesterol diet, administration of solution of posterior pituitary for the control of the diabetes insipidus and roentgen therapy applied to the lesions. The pathologic condition in the Hand-Schüller-Christian syndrome is radiosensitive, so that surgical intervention should be avoided. The prognosis is made worse by surgical attempts, and Shea<sup>20</sup> cited 2 cases in which death followed operation.

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16. Montgomery, H., and Osterberg, A. E.: Xanthomatosis: Correlation of Clinical Histopathologic and Chemical Studies of Cutaneous Xanthoma, *Arch. Dermat. & Syph.* **37**:373-402 (March) 1938.

17. Sobotka, H.; Reiner, M.; Glick, D., and Tuchman, L.: The Lipoids of Spleen and Liver in Various Types of Lipoidoses, *Biochem. J.* **27**:2031-2034, 1933.

18. Mettel, H. B.: Xanthomatosis, *Am. J. Dis. Child.* **42**:858-863 (Oct.) 1931.

19. Druss, J. G.: Aural Manifestations of Lipoid Granulomatosis (Hand-Schüller-Christian's Disease), *Ann. Otol., Rhin. & Laryng.* **45**:693-702 (Sept.) 1936.

20. Shea, J. J.: Xanthomatosis (Schüller-Christian's Disease): A Report of a Case with Radiosensitive Pathology in Mastoid, *Laryngoscope* **48**:589-598 (Aug.) 1938.

*Gaucher's Syndrome.*—This syndrome is often called familial splenic anemia and was first described in 1882. Mandelbaum and Downey, thirty-four years later, discovered the underlying metabolic disturbance. Since then the lipoid that is stored in Gaucher's syndrome has been found to be kerasin, a cerebroside.<sup>17</sup> In contrast, this symptom complex occurs much more in females and in Jews. In this syndrome also the basic etiologic factor has not been determined.

Early findings are cachectic symptoms, splenomegaly, yellow brown to ochre spotting of the skin (particularly on the face, neck and hands) and hypochromic anemia. Hepatomegaly, leukopenia, pain in the lower ends of the tibia and femur and tenderness over the sternum and ribs, due to bony involvement,<sup>4</sup> appear later. The cortex osseum in these areas appears on roentgen examination to be thinned. Diagnosis can be made on the basis of the symptoms and on that of Gaucher cells shown by biopsy of involved bone marrow removed by punch. The latter are large cells with one or more nuclei and a glossy, homogeneous spongioplasm. These cells are seen also in the liver and spleen, being derived from reticulum cells.

Treatment has proved ineffective, and the patient usually dies of some intercurrent infection in the early decades.

*Niemann-Pick Syndrome.*—This condition is similar to Gaucher's syndrome, but more rare. It is congenital, hereditary and more frequent in females and in Jews. Although etiologic factors of this condition too are unknown, it has been proved that a storage of phosphatides occurs, with an increase in other lipoids.<sup>17</sup> These are abnormally stored in reticuloendothelial connective tissue and in epithelial cells, so that eventually function is too affected to permit life. Hypothetically, some profound disturbance of fatty metabolism must underlie such a condition.

The infant with this syndrome shows rapid abdominal enlargement, together with splenohepatomegaly and mild ascites, yellowish brown discoloration of exposed skin, mild anemia, edema and a varying degree of lymphadenopathy. As an aid in diagnosis, vacuoles are found in the polymorphonuclears and the lymphocytes.

Treatment is ineffective and awaits more knowledge concerning cause. Unfortunately the condition proves fatal, as a rule, by the fourth year.<sup>21</sup>

*Amaurotic Family Idiocy and Tay-Sachs Syndrome.*—Briefly, these afflictions can be described as a fundamental disturbance in lipid metabolism, in which the deposition is confined more to the ganglionic

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21. Rogers, F. M.: Xanthomatosis of Orbit (Lipogranuloma) in Patient with Diabetes Insipidus, *Am. J. Ophth.* **17**:1141-1145 (Dec.) 1934.



and glial cells.<sup>22</sup> The name Tay-Sachs syndrome designates in present usage a more severe, fulminating type of amaurotic family idiocy.

*Extracellular Cholesterosis.*—This was first described by Kerl, of Vienna, in 1930 as a condition in which cholesterol and cholesterol esters are deposited extracellularly.<sup>8</sup> Characteristic findings are hepatic disturbances and yellowish blue nodules of glassy transparency on the skin and on the mucous membrane of the mouth and pharynx. It has been shown that hypolipemia is more common. Roentgen therapy serves efficiently.

*Lipoid Proteinosis.*—Urbach and Wiethe in 1924 reported this condition as resulting from the deposition of acetone-soluble lipoid in physical combination with an unknown lipoid.<sup>9</sup> Patients so affected complain of repeated oral and pharyngeal inflammations with resultant small scars. These are due to initial yellowish, plaquelike elevations on the inner surface of lips, palate and tongue. The latter may become so involved as to result in partial destruction of some mobility and taste. Other mucous membranes may be involved; in fact, tracheotomy has been required. Treatment is yet unfavorable.

#### SUMMARY

My purpose in this paper has been to describe a condition appearing as a hemangioblastoma with pseudoxanthomatous change and to discuss briefly the present day knowledge concerning the various lipoidoses.

A case in which a tentative diagnosis of hemangioblastoma with pseudoxanthomatous change was made is reported.

The pathologic observations in the reported case are compared with those of reliable authorities.

It is noted that surgical removal of such growths often proves difficult or impossible.

Consideration of the literature concerning xanthomatous pathology prompts a review of the "lipoidoses," a suitable term because all the conditions falling into this group have some underlying disturbance of lipid metabolism.

Xanthoma tuberosum is described as a form of localized lipoidosis. Etiologic factors are stressed.

Xanthomatosis is a more common form of generalized lipoidosis. As to its cause, perhaps the best one can do is to hypothesize that a lipid imbalance between certain cells and the blood stream or a disturbance in lipid metabolism, either locally or generally, accounts for the characteristic pathologic condition.

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22. Pick, L.: Niemann-Pick's Disease and Other So-Called Xanthomatoses, *Am. J. M. Sc.* **185**:601-616 (May) 1933.

In the Hand-Schüller-Christian syndrome an abnormal storage of cholesterol and its esters occurs. The most characteristic findings include exophthalmos, diabetes insipidus and osseous defects (particularly in the skull) of moth-eaten appearance.

Gaucher's syndrome, or familial splenic anemia, is accompanied by the lipoid storage of kersin. Diagnosis is made on the basis of symptoms and of Gaucher cells shown by biopsy of involved bone marrow removed by punch. Prognosis is not good.

Phosphatides are stored extensively within the cells in the Niemann-Pick syndrome. Consequently the physiologic processes are so damaged that the afflicted infant dies, as a rule, by the second to the fourth year.

For completeness amaurotic family idiocy, the Tay-Sachs syndrome, extracellular cholesterosis and lipoid proteinosis are described briefly.

In all these types of lipoidoses treatment awaits, for the most part, further experimentation in regard to underlying cause.

# CAVERNOUS SINUS THROMBOSIS

## REPORT OF RECOVERY FOLLOWING SULFAPYRIDINE THERAPY

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AND

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The subject of cavernous sinus thrombosis has been ably presented and discussed by various authors, notably by Dwight and Germain,<sup>1</sup> Eagleton,<sup>2</sup> Turner and Reynolds<sup>3</sup> and Irish.<sup>4</sup> It is the purpose of this paper to present data on a patient who recovered from cavernous sinus thrombosis and to give the details of therapy. Sulfapyridine was used as the chemotherapeutic agent.

Turner and Reynolds,<sup>3</sup> like most authors, described acute and chronic forms of cavernous sinus thrombosis. The acute fulminating type has a high mortality. It spreads rapidly by direct extension, usually along the ophthalmic veins, traveling with, rather than against, the normal venous flow. The chronic type is more insidious in onset. The infection usually has its origin in the middle ear and gains entrance to the cavernous sinus by way of a retrograde thrombosis of the petrosal sinuses. Cavenagh<sup>5</sup> pointed out that chronic thrombosis of the cavernous sinus has a lower mortality rate than the acute form. The case to be presented is typical of the acute fulminating type.

The diagnosis of cavernous sinus thrombosis in a patient who recovered and on whom surgical intervention was not employed to visualize the thrombosis and allow removal of adequate material for histologic study is justly open to criticism. In a few instances, a perusal of the available literature on the reported cases of recovery brings forth

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1. Dwight, E. N., and Germain, H.: *Thrombosis of the Cavernous Sinus with Report of Four Cases Including One Cranial Operation*, Boston M. & S. J. **146**:456, 1902.

2. Eagleton, W. P.: *Cavernous Sinus Thrombophlebitis*, New York, The Macmillan Company, 1926.

3. Turner, L. A., and Reynolds, E. F.: *Intracranial Pyogenic Diseases*, Edinburgh, Oliver & Boyd, 1931.

4. Irish, C. W.: *Sinus Thrombosis: Cavernous Sinus Thrombosis*, Ann. Otol., Rhin. & Laryng. **47**:411 (June) 1938.

5. Cavenagh, J. B.: *Cavernous Sinus Thrombosis: Study of Cases of Recovery*, Brit. M. J. **1**:1195 (June 13) 1936.

questions as to the authenticity of such a diagnosis in the mind of the least skeptical reader. Eagleton<sup>2</sup> outlined certain points essential to allow the diagnosis. They are: (1) a known site of infection; (2) evidence of infection of the blood stream; (3) early signs of venous obstruction in the retina, conjunctiva or eyelid; (4) paresis of the third, fourth and sixth nerves resulting from pressure caused by inflammatory edema; (5) the formation of an abscess in the neighboring soft tissues, and (6) evidences of meningeal irritation.

The findings in the case presented fulfil all of these requirements, and we feel that an evaluation of the clinical and laboratory data substantiates the diagnosis of cavernous sinus thrombosis against the most severe criticism.

It is well known that thrombophlebitis of the cavernous sinus is a serious disease. Abercrombie<sup>6</sup> recognized this fact when he described the disease for the first time in 1818. In 1902 Dwight and Germain<sup>1</sup> collected reports of 182 cases of cavernous sinus thrombosis and found that 7 per cent of the patients recovered spontaneously. Since that time the mortality rate has not changed. Chisolm and Watkins,<sup>7</sup> in 1920, noted that of those patients operated on less than 7 per cent recovered. In 1926, Eagleton<sup>2</sup> personally observed 25 patients with cavernous sinus thrombosis, of whom 3 recovered. Five years later, Turner and Reynolds<sup>3</sup> reported 22 cases with only 1 recovery. Irish,<sup>4</sup> in his analysis of 34 cases in which postmortem examination was made, found that in 14 cases, or 41 per cent, the infectious source was at, or about, the nose and upper lip. The infecting organism almost invariably was proved to be *Staphylococcus aureus*. Early in 1939, Barnshaw<sup>8</sup> reported the recovery of a patient who had staphylococcic cavernous sinus thrombosis following treatment with sulfanilamide, and in the same year Seydell<sup>9</sup> reported a case in which treatment with sulfanilamide was given. Presumably the infecting organism in Seydell's patient was the hemolytic streptococcus, though cultures were taken only from the ear, which was the focus of infection.

O'Brien and McCarthy<sup>10</sup> in 1938, suggested the value of sulapyridine in treatment of serious staphylococcic infections, and since that

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6. Abercrombie, J.: *Pathological and Practical Researches on Diseases of the Brain and Spinal Cord*, Philadelphia, Lea & Blanchard, 1843.

7. Chisolm, J. J., and Watkins, S. S.: Twelve Cases of Thrombosis of the Cavernous Sinus, from a Study of Fifty Thousand Surgical Histories in Johns Hopkins Hospital, *Arch. Surg.* **1**:483 (Nov.) 1920.

8. Barnshaw, H. B.: Report of a Case of Bilateral Cavernous Sinus Thrombosis: Recovery Without Operative Intervention, *J. M. Soc. New Jersey* **36**:22 (Jan.) 1939.

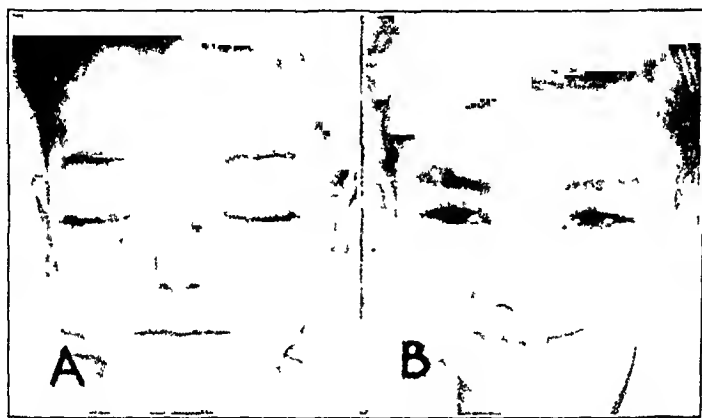
9. Seydell, E. M.: Recovery from Thrombosis of the Cavernous Sinus, *Arch. Otolaryng.* **30**:429 (Sept.) 1939.

10. O'Brien, E. J., and McCarthy, C. J.: Staphylococcal Septicemia Treated with M. & B. 693, *Lancet* **2**:1236, 1938.

time others have verified its effectiveness. Long and Bliss<sup>11</sup> pointed out that sulfapyridine is the most effective chemotherapeutic agent against the staphylococcus thus far developed. With this in mind, we present the record of a patient treated with sulfapyridine for acute staphylococcic cavernous sinus thrombosis.

#### REPORT OF A CASE

W. S., a boy 5 years of age, of Greek parentage, entered the isolation department of the San Francisco City and County Hospital on July 27, 1939, because of possible erysipelas. He had been in good health until six days before his admission, at which time it was noticed that he had a "small pimple" at the tip of his nose on the left side. The parents said that the child had "picked" at the lesion several times. Three days prior to entry, the nose was red and swollen and the left eye appeared "puffy." The redness and swelling increased. On the morning of the patient's admission to the hospital both eyes were swollen shut. The staff examined



Cavernous sinus thrombosis. *A*, during the acute phase. *B*, seventeen days later, after treatment with sulfapyridine.

the patient and thought that he had acute ethmoid or frontal sinusitis. He was then transferred to the ear, nose and throat service.

Examination on the evening of July 28 showed the boy to be acutely ill. He weighed 38.5 pounds (17.5 Kg.). The temperature was 104.4 F., the pulse rate 148 and the respiration rate 36. The child lay in an opisthotonos posture and was listless and unresponsive. There was a small, almost healed lesion at the site of the initial infection on the left ala nasi. (This area is still faintly discernible in view *A* of the figure, taken on August 2. It should not be confused with the easily seen localized abscess that developed medial to, and slightly below, the inner canthus of the left eye.) There was a diffuse swelling of the soft tissues of the forehead, the bridge of the nose and the left side of the face. The skin had a purplish hue. The superficial branches of the left angular vein appeared to be thrombosed. There were numerous prominent, dark veins over the forehead, left cheek and chin. Both eyes were swollen shut, and there was discoloration of the swollen tissues, as shown in view *A* of the figure. Edema of the conjunctiva

11. Long, P. H., and Bliss, E. A.: The Clinical and Experimental Use of Sulfanilamide, Sulfapyridine and Allied Compounds, New York, The Macmillan Company, 1939.

and chemosis were present in both eyes. The extraocular movements were markedly limited in all directions. The pupils reacted to light and in accommodation. It was difficult to examine the fundi. The disk margins were blurred and the retinal vessels engorged. No retinal hemorrhages or choking of optic disks was noted.

The reflexes were hyperactive. There was a suggestion of stiffness of the neck. Kernig's and Brudzinski's signs were questionably positive, and Babinski's sign was normal.

*Laboratory Findings.*—The urine was normal in all respects and remained so throughout the course of sulfapyridine therapy and the period of hospitalization, as ascertained by daily examination.

The results of examination of the blood are shown in the following tabulation:

	On Entry	Greatest Variation	On Discharge
Hemoglobin .....	100%	72%	85%
Red blood cells.....	5,300,000	4,460,000	4,500,000
White blood cells.....	18,100	38,950	13,200
Polymorphonuclears .....	75%	84%	68%
Filamented cells .....	46%	68%	48%
Nonfilamented cells .....	29%	16%	20%

The hemoglobin value and white blood cell count were determined daily during the course of the sulfapyridine therapy.

Culture of the blood revealed a positive growth of hemolytic *Staph. aureus*.

Tests with both human and bovine tuberculins in dilutions of 1:1,000 gave negative results.

Lumbar puncture was performed at the time of admission, because of signs of meningeal irritation, and the pressure of the spinal fluid was 150 cm. of water. The Queckenstedt maneuver showed both lateral sinuses to be patent. There were no cells and no bacterial growth. The reaction to the Pandy test was negative.

Roentgen examination showed normal accessory nasal sinuses.

*Treatment.*—Sulfapyridine therapy was started on July 29, the day after admission, after a report from the laboratory that blood obtained the day before showed a heavy growth of hemolytic *Staph. aureus*. The child received 1 Gm. (15 grains) of the drug every four hours, a total of 6 Gm. (90 grains) each twenty-four hours; that is, the patient received 0.34 Gm. per kilogram, or slightly over  $2\frac{1}{3}$  grains per pound, of body weight, each twenty-four hours. Daily titers showed that this dosage maintained a sulfapyridine level in the blood stream of not less than 10.4 nor more than 16.5 mg. per hundred cubic centimeters. This dosage was maintained for nine days, and then, because the patient was making such excellent progress, the amount was gradually diminished until, after six more days, the drug was withheld entirely. Sodium bicarbonate was administered in amounts equal to those of the sulfapyridine. The total amount of sulfapyridine administered was 63 Gm. (945 grains). No nausea or vomiting was noted. There was moderate cyanosis of the lips and finger nails. There was no evidence of jaundice, hemolytic anemia or renal damage. The patient received five daily transfusions of 250 cc. of nonimmunized blood. The eyes were treated with 5 per cent boric acid ointment.

The question as to the advisability of supplementing or even supplanting the sulfapyridine therapy with staphylococcus toxoid or antiserum arose as soon as it was established that the blood culture showed a positive growth of *Staph. aureus*. When the report of the culture of the material removed from the abscess likewise showed a pure culture of hemolytic *Staph. aureus*, there was another wave of enthusiasm in favor of instituting specific therapy with the biologic preparations. We did not deem it advisable, and in retrospect we are pleased that the ultimate results are not confused by two or more forms of therapy.

The total fluid intake and output were recorded daily. The intake of fluid ranged between 2,300 and 3,000 cc. in twenty-four hours. From 500 to 1,000 cc. of a 5 per cent solution of dextrose was administered intravenously daily to bring the fluid intake up to the desired level. The urinary output was from 1,200 to 1,500 cc. per day.

*Course.*—The swelling about the eyes increased, and three days after entry the right eye protruded more than the left, as shown in the figure. Dr. W. D. Horner, of the ophthalmic service, examined the patient at that time and found both eyes swollen, proptosis present and the conjunctiva of the right globe irregularly swollen. The ocular movements were limited in all directions. There was edema over the brow, showing impeded venous return. The periocular tissues were discolored and swollen. The cornea was normal. The pupils reacted promptly to light. The right disk was not seen in detail. The outlines of the left disk were blurred, but the disk was not definitely choked. Dr. Horner stated the opinion that the proptosis, the edema of the brow and the blurred disks warranted the diagnosis of cavernous sinus thrombosis.

The edema about the eyes and forehead became fluctuant on the fourth day after entry. An abscess pointed about 1 cm. medial to the inner canthus of the left eye along the nasal bridge. This was incised and drained. About 10 cc. of pus was expressed from along the eyelids, nose and forehead, and a short rubber drain was inserted. The wound continued to discharge for several days, after which the rubber drain was removed. Culture of the pus from this abscess yielded an uncontaminated growth of hemolytic *Staph. aureus*.

The patient's temperature dropped gradually, became normal eleven days after his entry to the hospital and has remained so. The dose of sulfapyridine was decreased beginning on the eleventh day, and the use of the drug was stopped entirely on the sixteenth day.

The proptosis, edema and discoloration about the eyes receded slowly, so that on the ninth day after entry the child could open his eyes about halfway. The chemosis disappeared more slowly. When the patient was discharged, twenty-eight days after entry, there was still slight edema of the conjunctiva of the right eye, but one month later this was entirely gone. Three months after the patient's discharge, his extraocular movements and vision were normal; the urine, examined for possible renal damage resulting from sulfapyridine therapy, was normal. The boy gained over 6 pounds (2.7 Kg.) during the three months.

#### COMMENT

Thus far no reports have appeared in the literature pertaining to the use of sulfapyridine in the treatment of cavernous sinus thrombosis. It is inevitable that the drug will be used in the treatment of this disease, as there is suggestive evidence of its chemotherapeutic value against other staphylococcic infections.

Long and Bliss<sup>11</sup> observed that each patient differs in rate of absorption and excretion of sulfanilamide and its allied compounds. This is borne out in our experience in treating patients with sulfanilamide and with sulfapyridine, especially with the latter. When the drug sulfanilamide is indicated, one can be fairly certain that the administration of 0.15 Gm. per kilogram (approximately 1 grain per pound) of body weight in twenty-four hours will usually maintain a level in the blood

of from 10 to 15 mg. per hundred cubic centimeters. Hobson and McQuaide<sup>12</sup> showed that such is not the case with sulfapyridine. We have observed various patients treated with sulfapyridine who have had greater fluctuations in absorption and excretion of the drug. In the treatment of the patient in the case just reported it was necessary to administer 0.34 Gm. per kilogram of body weight ( $2\frac{1}{3}$  grains per pound) each twenty-four hour period to maintain a level in the blood of from 10 to 15 mg. per hundred cubic centimeters. This is more than twice the expected dose of sulfanilamide.

In the use of sulfanilamide, various authors recommend the restriction of intake of fluids in order to obtain and maintain a higher concentration of the drug in the body. We believe that in the use of sulfapyridine as a chemotherapeutic agent this is a dangerous procedure. Molitor<sup>13</sup> showed in experimental animals that when high concentrations of sulfapyridine are administered there is a decrease in renal function, as well as subsequent development of sulfapyridine calculi. Indeed, Long and Bliss<sup>11</sup> have a special added chapter in their book, stressing that they had observed several patients being treated with sulfapyridine who suffered from anuria and presented evidences of decreased renal function. The toxic manifestations have been shown to result from acetylsulfapyridine calculi in the renal tubules and kidney pelvis. Tsao, McCracken, Chew, Kuo and Dale<sup>14</sup> recently reported 5 cases of renal complications following sulfapyridine therapy. One child died, and post-mortem examination revealed calculi in the ureters. Unfortunately, the calculi were not examined for sulfapyridine. Recently, we saw the post-mortem examination of a child who died of tuberculous meningitis and who had been treated with large doses of sulfapyridine. Within the ureters and renal pelvis were numerous crystals. Unfortunately, the organs were placed in a 4 per cent solution of formaldehyde, and the crystals disappeared before they could be analyzed. Long and Bliss<sup>11</sup> suggested the use of sodium bicarbonate with sulfapyridine therapy, with the hope that an alkaline urine might inhibit formation of acetyl sulfapyridine in the kidneys. We wish to point out that the patients reported on by Tsao and others, as well as the child with tuberculous meningitis, received sodium bicarbonate and had alkaline urine, yet showed renal damage resulting from the administration of sulfapyridine. Until more is known about the action of acetyl sulfapyridine on the kidneys it may be wiser to force, rather than restrict, the intake of fluids.

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12. Hobson, F. G., and McQuaide, D. H. G.: Treatment of Meningococcal Meningitis with 2-Sulphanilyl-Amidopyridine (M. & B. 693), *Lancet* **2**:1213, 1938.

13. Molitor, H., cited by Long and Bliss,<sup>11</sup> p. 60.

14. Tsao, Y. F.; McCracken, M. E.; Chew, J.; Kuo, P. T., and Dale, C. L.: Renal Complications in Sulfapyridine Therapy: Report of Five Cases with One Death, *J. A. M. A.* **113**:1316 (Sept. 30) 1939.



In the case of our patient, the fluid intake ranged between 2,300 and 3,000 cc. daily. Despite high concentration of sulfapyridine, no evidence of renal damage was noted.

Vomiting does not occur more frequently after the administration of sulfapyridine than it does after that of sulfanilamide. Marshall<sup>15</sup> reported the intravenous use of a 5 per cent sodium salt of sulfapyridine. This, however, is not available for commercial use as yet. If necessary, a nasal tube may offer an excellent way of administering the drug.

Anemia of varying degrees may occur when sulfapyridine is administered in large doses. This anemia does not warrant discontinuing the use of the drug if one is dealing with a serious illness. Small frequent transfusions replace the loss in hemoglobin. Our patient received transfusions of 250 cc. of citrated blood daily for five days. Unquestionably these transfusions had much to do with the boy's recovery. Yet we were impressed by the startling improvement he showed while he was receiving sulfapyridine therapy.

#### SUMMARY

A recovery following thrombosis of the cavernous sinus is presented.

The details of therapy are given. Sulfapyridine was used as a chemotherapeutic agent; a total of 63 Gm. (945 grains) was administered. Excepting mild cyanosis, no subjective or objective reaction to the drug was observed.

The diagnosis of cavernous sinus thrombosis was made on both clinical and laboratory findings and is offered for inspection and criticism.

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15. Marshall, E. K., cited by Long and Bliss,<sup>11</sup> p. 230.

# A SIMPLIFIED TECHNIC FOR THE CONSTRUCTION OF LIFE MASKS OF LATEX RUBBER

SAMUEL PELUSE, M.D.

LOS ANGELES

Life masks made of latex rubber have many advantages over models composed of other materials, such as wax, plaster of paris and similar substances. Rubber models are unbreakable and unaltered by rough usage. Storage problems are simplified, as the models may be stacked high in small spaces without damage. Flexibility of reproduced features facilitates the preoperative planning of reconstructive surgical operations about the face. Mounting of these models is relatively simple and effective.

The construction of life masks of latex rubber in accordance with my technic necessitates a practical knowledge of moulage materials and of plaster of paris molds. The familiar method of constructing a plaster of paris mold directly from the subject's face has been discarded for several reasons, namely, premature separation of the rubber in the mold, due to the grease used as a separating medium on the face; loss of skin texture and detail; difficulty of modeling the defects in the resultant mold, and inadvisability of pouring plaster of paris on the subject's face while the eyes are open.

## MATERIALS

A list of the materials used in my process of constructing a finished life mask in rubber follows:

1. A piece of flexible wire <sup>1</sup> about 18 inches (45 cm.) long for outlining the contour of the face.
2. A rigid piece of cardboard about 15 inches (38 cm.) square.
3. Thermometer, spatula and several inexpensive brushes about 1 inch (2.5 cm.) wide.
4. Commerical hydrocolloidal compound <sup>2</sup> for making the "negative" impression of the subject's face.
5. Plaster of paris bandages.

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1. Ordinary solid soldering wire is used.

2. The commercial hydrocolloidal compound employed is that known as plastico moulage. The supply used by me was furnished by the manufacturer, Technical Supply Company, Palo Alto, Calif.

6. Wax compound<sup>3</sup> for the wax "positive" cast.
7. Modeling clay to repair defects and trim up the wax cast.
8. Plaster of paris.<sup>4</sup>
9. Liquid latex rubber.

#### OUTLINE OF THE PROCESS

1. Constructing the "negative" impression (mold) with the hydrocolloidal compound.
2. Casting the wax "positive" (cast).
3. Modeling and correcting the defects of the wax cast with modeling clay.
4. Preparing the plaster of paris mold from the modeled wax cast.
5. Building the latex rubber "positive" cast in the plaster of paris mold.
6. Inserting the glass eyes.
7. Mounting the finished latex rubber model.

#### TECHNIC IN DETAIL

##### 1. *Constructing the "Negative" Impression (Mold) with the Hydrocolloidal Compound (Moulage Material).*

###### A. Preparing the moulage compound.

About 5 pounds (2.3 Kg.) of the hydrocolloidal compound is melted in a 2 quart (1,890 cc.) double boiler until the material has a smooth, thick, creamy consistency. The lumps are worked out with a spatula or potato masher. One to one and a half hours is allowed for melting the moulage.

The material is cooled to approximately 110 F., and at this temperature it should just flow from the spatula to be the proper consistency for application. If the material appears too thick, small amounts of water may be added and mixed thoroughly until it flows.

###### B. Making the moulage "negative" (mold).

(1) Preparing the patient. No preparation of the face is necessary. The subject is placed in a comfortable reclining chair or allowed to lie supine on a table, with the chin well up, so that the neck line is smooth of wrinkles.

(2) Cutting the cardboard form. If the mask to be made does not include the ears a cardboard form is made. A soft, flexible wire (fig. 1 A) is passed over the vertex of the head, down in front of both

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3. A commercial wax compound known as *plastico posmoulage* is used; this was supplied me by the manufacturer, the Technical Supply Company.

4. The plaster of paris used is a hard type known as *hydrocal* (a product of the United States Gypsum Co.).

ears and under the chin, the wire being shaped closely to the face. This shaped wire is outlined in pencil on a square piece of rigid cardboard. The penciled outline is cut out with a sharp knife, and the form is tried on the subject's face. It should fit snugly, but not too tightly to distort the soft parts, resting lightly on both tragi (in front of the ears). A folded towel placed over the thyroid cartilage supports the board on the neck. The hair is snugly fitted to the scalp by the shaped cardboard.

(3) Applying the moulage material. The subject's eyes may be cast open or closed. The following process describes the technic of casting with the eyes open: The first application begins in the region of the neck under the chin (fig. 1 *B*). The warm moulage material is brushed upward from the cardboard along the neck to the chin and worked over the chin to the lower lip. It is necessary to brush briskly in order to avoid the forming of air bubbles. However, the material is laid gently over the lips with no brushing in order to avoid distortion of the lip contour. The material is then brushed along the side of the face, the application of this first layer being upward always. The upward motion is essential to avoid sagging of the facial muscles because of the heavy moulage material.

In the region of the nose, the brushing may be downward over the dorsum and alae. A small size, no. 10, camel's hair brush is used to form the nostrils. The material is worked rapidly over the columellar and alar regions, some being brushed into the nares. If some of the substance accidentally obstructs breathing, two or three sharp exhalations by the subject will clear the air passages. It is important that the breathing be unobstructed, as the subject may become panicky and interfere with the work done so far.

The operator should speak reassuringly to the subject during the entire process, and communication is carried on by means of paper and pencil provided for that purpose.

The application of the moulage material about the open eyes needs special attention. The subject is instructed to stare ceilingward and cautioned about blinking for a short period. With the camel's hair brush, a thin layer is placed on the upper lid and allowed to *flow* to the eyelashes. The inner canthus next is shaped, and a heavy layer is constructed over the upper lid by repeated applications of moulage.<sup>5</sup>

The eyebrow is covered by allowing the material to *flow* over the hairs. *Moulage material is never brushed into hairy areas.* The opposite upper eyelid and eyebrow are treated similarly.

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5. Moulage material is not injurious to the cornea; I use it regularly to make impressions (molds) of the eyeball for contact lens construction. If it is desired to cast the subject with eyes closed, the process is similar except that the moulage material is brushed gently over the closed lids.

The lower lids are covered by brushing the material to the lashes, and a thick layer is formed by repeated applications. If the subject blinks while the moulage material is still warm no harm is done, as the material will stretch a short distance and follow the lids. However, after the material has set, blinking will cause the lids to pull away, leaving behind well formed impressions.

The forehead is covered by brushing and the hair by allowing the material to flow over the surface. The desired thickness of the mold, which is approximately  $\frac{3}{4}$  inch (1.91 cm.), is attained by heaping up the material over the first layer.

An electric fan is an aid in cooling and hardening the mass. When the mass has cooled, it is well to palpate over the whole surface for thin



Fig. 1.—*A*, the first step in the process of casting a life mask of latex rubber made with the subject's eyes open. A soft, flexible wire is used for outlining the contour of the face. *B*, the cardboard cut out and in place. The subject is supine with the chin elevated. The beginning of the application of the moulage material at the neck line is shown.

spots. If present, these may be reenforced by applying additional material over the areas. This new material is then cooled.

The moulage material when hardened is flexible, and a rigid support of some backing material is necessary to maintain its shape. Plaster of paris is satisfactory for this purpose and is applied in the form of bandage rolls.

(4) Preparing the plaster of paris bandages. These bandages may be purchased but can be made quite inexpensively, as follows: A roll of

crinolin, 4 inches (10 cm.) wide and 100 yards (91 meters) long, and 10 pounds (4.5 Kg.) of quick-setting dental plaster will make sufficient bandages for numerous masks. The plaster is rubbed into the crinolin mesh, about 5 foot (150 cm.) lengths being used to make up each roll. These lengths are rolled loosely and wrapped in tissue paper until ready for use. About three or four of these rolls are sufficient for one mask.

(5) Making the paster of paris shell. One of the plaster of paris rolls is laid in a deep basin of water and when the bubbling ceases is picked up by the ends and gently squeezed until the excess water is pressed out. This procedure retains the plaster in the roll.



Fig. 2.—*A*, the moulage material covering the entire face has been allowed to harden. The eyes are open and the nostrils unobstructed. The picture shows the first step in the reenforcement of the mold by using plaster of paris cross struts. *B*, the entire mold reenforced by being covered with a plaster of paris shell.

The first application of the wet plaster of paris is in the form of reenforcing cross struts (fig. 2 *A*). These are constructed by cutting four layers of bandage about 1 foot (30 cm.) long from the wet plaster roll and shaping them into a thick strip about 1 inch (2.5 cm.) wide by compressing the layers between the fingers the full length of the strip. This band, or strut, is placed lengthwise on the mold, starting over the forehead area and extending down over the dorsum of the nose, columella and chin. It is shaped snugly to the contour of the nose, care being taken not to block off the nares.

A second strut, about 8 inches (20 cm.) long and 1 inch (2.5 cm.) wide, is similarly made and placed crosswise over the first one at right

angles, starting at the tip of the nasal region and being molded to the alar areas and across the face.

The shell is completed by applying the wet plaster of paris bandages around the mold, starting at the base in direct contact with the cardboard, with each succeeding layer overlapping the preceding one about one third of the width, and working upward toward the outer canthus of the eye (fig. 2 *B*). An electric fan aids in hardening the shell rapidly.



Fig. 3.—Removing the wax from the moulage mold.

(6) Removing the impression material from the face. As soon as the plaster shell is dry and hard the mold is ready for removal. The operator places one hand over the shell so that the structure of crossed struts rests in the palm and supports the mold while the subject sits up and bends forward as far as possible. The mold is allowed to come away gently while the subject moves the muscles of the face. The chin is freed first. The hair is allowed to pull away last, care being taken at this point, as the hair may be embedded in the moulage material. The mold is examined and all loose particles removed with the camel's hair brush.

## 2. Casting the Wax "Positive."

There are two methods of making the wax positive. One is to pour in the melted wax and brush and roll it over the mold. The other is to brush it in entirely. In my technic the method used is the brushing-in, as the holes in the mold left by the eyes and nares preclude pouring in the wax.

A. Brushing in the wax. The wax is melted in a *double boiler* and brushed into the mold, preferably starting at the neck line and working upward. The brushing is done rapidly and firmly to avoid air bubbles. Each succeeding brushful overlaps the last one, advancing thus over the whole mold.

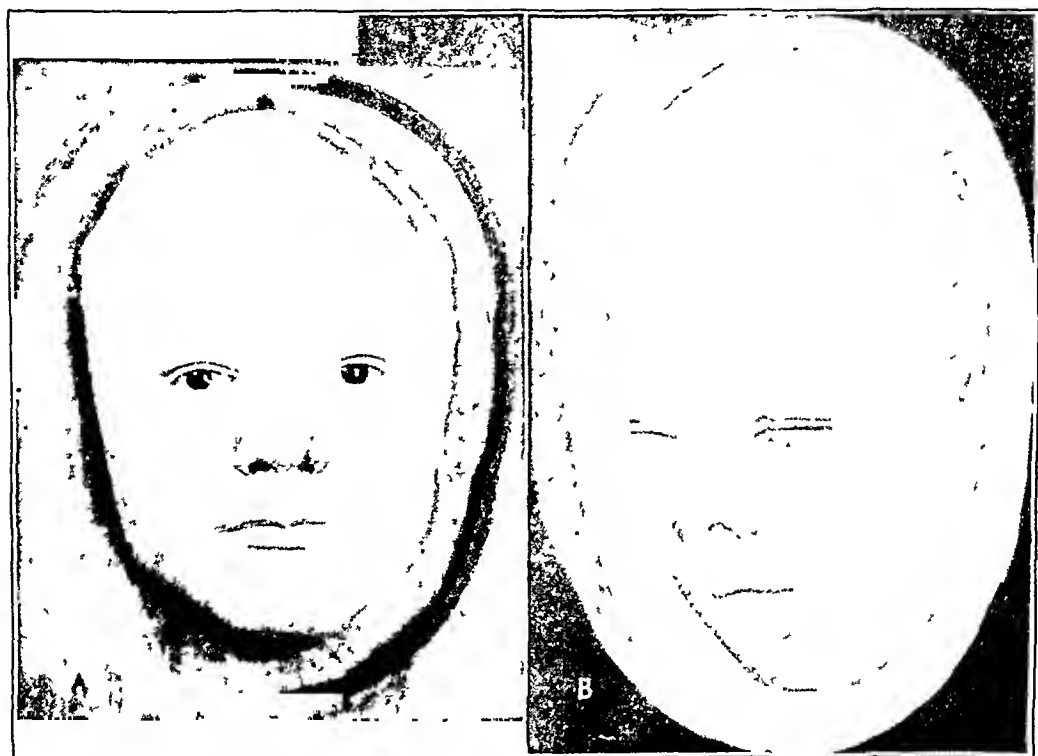


Fig. 4.—*A*, wax cast modeled and anchored to the board with modeling clay. Glass eyes have been inserted (artificial eyes may be sculptured with modeling clay if glass ones are not available). The clay dam is in place, in preparation for the making of the plaster of paris mold. *B*, the inside of the plaster of paris mold made from the wax cast shown in *A*.

B. Reenforcing the cast. After a thick layer of wax has been applied, a more rigid cast is made by reenforcing with gauze. Melted wax is brushed into the meshes of several layers of gauze laid over the first layer of wax. The finished cast should be about  $\frac{1}{8}$  inch (0.3 cm.) thick. It is cooled rapidly by allowing cold water to run gently into it and then carefully removed from the mold (fig. 3).

3. *Modeling and Correcting the Defects in the Wax Cast with Modeling Clay.*



Defects such as projections and humps are removed with a sharp knife or common wood-carving chisel. Depressed defects are remedied with modeling clay. This clay is also used for modeling the hair and improving the eyebrows. The nostrils are trimmed with a chisel.

The eyelids, upper and lower, are trimmed with a chisel and smoothed with clay. The palpebral fissures are preserved by the use of modeling clay or by fitting artificial eyes to the back of the lids. If clay is used, the eyeball contour may be sculptured with a modeling tool. If artificial eyes are used, the back of the lids may be shaped by melting the wax with an electric hotpoint and securing the artificial eyes in place with melted wax (fig. 4 A).

#### 4. *Preparing the Plaster of Paris Mold from the Modeled Wax Cast.*

The modeled mask is placed on a smooth board, face up, and the edges of the mask are anchored to the board with clay. A separating medium of clear lacquer or liquid soap is brushed over the clay areas. This material has a double function. It prevents the oil in the clay from penetrating the plaster mold and in addition acts as a means of separating the clay readily from the plaster.

With the modeling clay, a small dam is constructed about 1 inch (2.5 cm.) high, encircling the mask, about an inch of space being allowed between the mask edge and the dam (fig. 4 A).

A hard plaster of paris<sup>4</sup> is employed for the negative (mold). The quantity used is determined by the size of the model. For the average-sized mask about 3 pints (1,420 cc.) of water is poured into a large basin and the dry plaster of paris is sprinkled over the water by handfuls until small heaps of dry plaster remain on the surface of the water. It is customary to wait three minutes to allow the plaster to soak thoroughly and then stir rapidly with a spoon or with the hand until a fine, lumpless mixture is formed. When the mixture begins to set and is the consistency of thick cream, it is picked up in a cup and poured over the features, the mixture meanwhile being brushed well into the hair, eyes, nostrils and all crevices with the camel's hair brush.

A good deal of the plaster mixture will flow off into the gutter made by the clay, but it must be continually played over the features until a thick shell is formed, extending about 1 inch (2.5 cm.) over the highest point, which is the nasal tip. A flat surface is made on the top of the shell with the spatula so that the shell will remain level when turned up.

When the plaster has set, the shell is lifted from the board and turned over and the wax model removed. The heat generated while the plaster is setting softens the wax, making it pliable and easily removable with gentle manipulation. Any wax which remains firmly adherent may be floated off by allowing a stream of hot water to play over this area in the plaster mold.

Defects in the plaster of paris mold, such as air holes and broken areas, are repaired at once with a fresh plaster of paris mixture and a camel's hair brush. The completed mold is shown in figure 4 *B*.

5. *Building the Latex Rubber "Positive" Cast in the Plaster Mold.*

The plaster mold is thoroughly dried on a hot radiator or in an oven kept at approximately 150 F., with the oven door slightly open. Grease or oil is detrimental to the rubber cast, causing the rubber to pull away from the plaster, and therefore should not come in contact with the face of the mold.

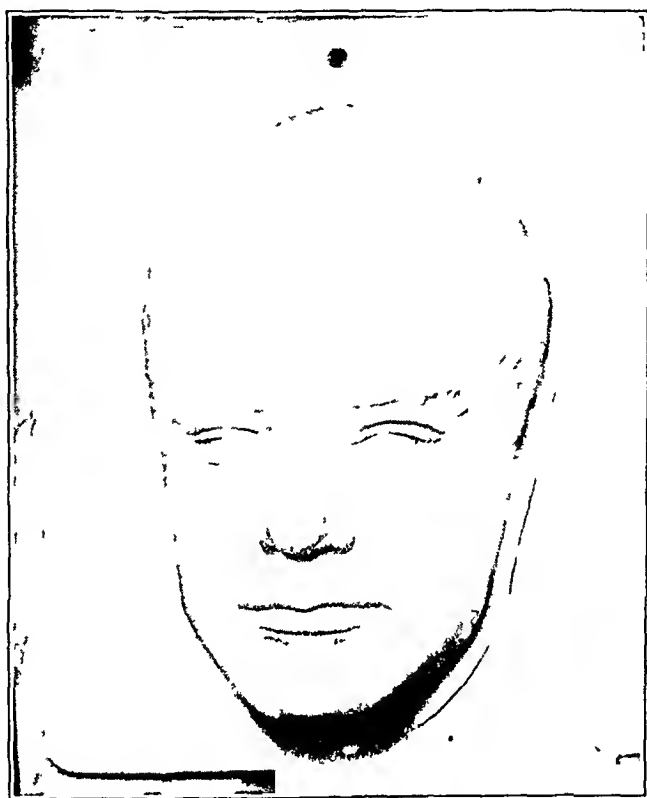


Fig. 5.—Rubber model removed from the mold shown in 5 *B*, mounted on a board, untinted. The palpebral fissures are intact.

Latex rubber is a thin white liquid and is applied in the following manner: An inexpensive brush about 1 inch (2.5 cm.) wide is prepared by dipping the bristles in soapsuds and then squeezing the excess off between the fingers. This facilitates the cleansing of the rubber-soaked brush after use. The liquid latex is brushed into the mold briskly, all bubbles being worked out and a thin, smooth layer of rubber being left on the surface of the negative. The first coat is allowed to dry (air vulcanization) thoroughly before the succeeding layers are applied. It takes about fifteen minutes to one-half hour to vulcanize in a warm room and less time in an oven at 150 F.

The oven temperature should never exceed 150 F., as the excess heat may cause the water in the rubber to vaporize, thus making the rubber

peel from the plaster. Succeeding coats are applied after each preceding coat has dried thoroughly.

After the fifth or sixth layer has been applied, the model is reenforced with gauze. A full thickness (8 ply) is placed evenly over the whole surface of the mold (except in the region of the palpebral fissures), and then the liquid rubber is brushed into the meshes of the gauze. No gauze is laid over the palpebral fissures, as these areas are to be cut out when the glass eyes are inserted and therefore should remain thin. The gauze layer is allowed to vulcanize approximately twenty-four hours (air vulcanization) before the final layer of rubber is brushed over the entire mold. When this last layer has dried, the rubber model is removed from the plaster.



Fig. 6.—The rubber model (left), in which glass eyes have been inserted and which has been tinted and mounted on a board. The finished model is shown in comparison with the subject.

Removal of the rubber model is done gently to avoid breaking off the projecting plaster nares. Small portions are stripped away from the plaster at a time until the whole model is free, and it is then removed (fig. 5).

#### 6. *Inserting the Glass Eyes.*

The thin diaphragm of rubber in the palpebral fissures is cut out with sharp scissors. The artificial eyes (color of iris matching the subject's) are manipulated in each socket until they are fitted accurately and the eyes appear straight. The socket may have to be trimmed with scissors or built up with liquid rubber to fit the flat artificial eye. Each eye, when properly alined, is held in place temporarily with adhesive

tape, and liquid latex is painted around the points of contact between the glass and the rubber socket and is allowed to vulcanize in place.

Artificial eyelashes<sup>6</sup> may be attached by cutting a deep groove along the full length of the upper lid with a sharp knife or a razor blade, keeping as close to the edge as possible. The base of the eyelash is inserted with a needle and anchored in place by applying a thin layer of liquid latex over the cut edge of the eyelid. The lashes in the lower lids may be painted in with a fine camel's hair brush and an appropriate color.

#### *7. Mounting the Finished Latex Rubber Model.*

Tinting of the models is accomplished with an air brush and special lacquers. This process is involved and will not be described in this paper. However, the untinted model may be mounted with pleasing results (fig. 5). This mounting is accomplished by trimming the thin projecting edge of rubber encircling the base of the model to a width of about  $\frac{1}{2}$  inch (1.3 cm.) and then, with ordinary small tacks, securing the projecting edge to an inexpensive breadboard.

A comparison of the finished model with the subject is shown in figure 6. The rubber model (left) has been tinted, and the glass eyes and artificial eyelashes have been inserted.

#### SUMMARY AND COMMENT

An economical method for the preparation and preservation of life masks made of latex rubber is described.

To any one doing plastic surgical procedure it is a valuable asset for preoperative planning and for record purposes.

This process has been taught as a part of postgraduate instruction in the department of otology, rhinology and laryngology of the University of Illinois College of Medicine for the past two years, and great interest has been evidenced when this material has been exhibited.

Latex rubber models have proved an excellent medium for instructional purposes in that department.

Knowledge of the preparation of life masks is the basis for the construction of prosthesis (rubber), a field in which the department has pioneered for the past fifteen years.<sup>7</sup>

Dr. Francis L. Lederer and Dr. Noah Fox gave me encouragement and inspiration in this work.

710 South Union.

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6. Artificial eyelashes may be purchased in any cosmetic shop.

7. Lederer, F. L.: Prosthetic Aids in Reconstructive Surgery About the Head, Arch. Otolaryng. 8:531 (Nov.) 1928.

# Case Reports

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## LYMPHANGIOMAS OF THE TONGUE

JAMES P. RIGG, M.D., AND RICHARD WALDAPEL, M.D., GRAND JUNCTION, COLO.

Enlargement of the tongue may be produced by various processes. Among those of noninfectious and nonmalignant nature the lymphangiomas represent a group of special interest and significance. They are not frequent, and various details of their occurrence and pathologic nature are still veiled in darkness. Every new report about such tumors is of importance and apt to make members of the medical profession more familiar with the nature of this growth.

The first pictured description of a clinical condition of this type is found in Virchow's article (1854) <sup>1</sup> "About Macroglossia and Pathologic New Formations of Striated Muscle Fibers," in which he showed that this type of enlargement is not a hypertrophy of the muscle tissue of the tongue as former authors thought and laid the basis of modern pathologic, anatomic and histologic knowledge of these tumors of the tongue.

Much of Virchow's description is still valid today; in some details knowledge has been enriched and somewhat changed by later investigators.<sup>2</sup> The mode of development of the tumors is still discussed; the most accepted theory is that the primary growth is a new formation of lymph vessels from a congenital anlage; another theory is that lingual lymph spaces become dilated, especially under the influence of inflammatory processes, and then penetrate more and more the surrounding tissue. It is of interest to note that the formations show, in the oral cavity, a predilection for places where in the embryologic development fissures were present and subsequently were closed. They are often noticed in childhood but remain small for a long time and then suddenly are exacerbated, usually as the result of an inflammatory process, after dentition or before puberty. Superficial trauma may bring about infection of the whole cavernous system of the growth. After such infectious attacks the tumor does not recede at all or only partially recedes, so that during life the tongue becomes bigger and bigger. The characteristic detail in the clinical picture of this enlargement is the granulating surface, which is formed by smaller and larger vesicles filled with fluid.

Today these formations are divided into three types.

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From the Eye, Ear, Nose and Throat Clinic.

Presented before the Colorado Otolaryngological Society, Denver, Sept. 30, 1939.

1. Virchow, J.: Ueber Makroglossie und pathologische Neubildung von quergestreiften Muskelfasern, Virchows Arch. f. path. Anat. 7:127, 1854.

2. Mikulicz, J., and Kümmel, W.: Die Krankheiten des Mundes, Jena, G. Fischer, 1922. Spencer, W., and Cade, S.: Diseases of the Tongue, Philadelphia, P. Blakiston's Son & Co., 1931. These books contain a complete bibliography.

1. The nodular or wart-shaped lymphangioma, which, in the form of smaller and larger tumors, is elevated above the surface of the tongue, mostly on the margin and on the base, and gives the appearance of hypertrophy of the papillae of the tongue, but when the growth is exactly examined with a loop the vesicles mentioned are discernible.

2. The diffuse lymphangioma, the real "macroglossia," which also shows the characteristic small vesicles but in which, from these vesicles, not isolated little masses but the affected part of the tongue as a whole is diffusely enlarged.

3. The cystic lymphangioma, or the lymph cyst, mentioned only to complete the picture, which represents a great rarity and consists of one big lymph cavity which is regarded as a lymph cyst.

Every tumor, as already mentioned, has its own peculiarities, brings out new details and more fully completes the knowledge of this interest-



Fig. 1.—Diffuse lymphangioma of the tongue. *A*, view from the front; *L* indicates the main tumor. *B*, view from the side; *L* indicates main tumor and *L*<sub>1</sub> the second tumor.

ing formation on the tongue. In the following case reports observations and findings are presented which will enhance knowledge concerning types 1 and 2.

#### REPORT OF CASES

CASE 1.—A youth, B. St. J., aged 18, reported to the office with the following history: At the age of 5 years he bit his tongue, and the lesion looked like a blood blister for a while. It improved somewhat, but he again bit his tongue, which grew slowly until it showed its present size and shape. This picture had persisted for the past four or five years without any appreciable change. The whole tumor seemed to have first started under the tongue and only later on had spread over the upper surface of the tongue. The patient did not feel any discomfort when eating, and the condition did not bother him in any respect.

The tongue (fig. 1 *A*) represented an impressive picture. Two distinct areas appeared on the upper surface. On the right half was the normal surface of the

tongue, showing no pathologic change; the left half was elevated high above the normal right part and consisted of harder and more elastic tissue. The left part had rough granulations of the surface, which, as was to be recognized with the naked eye and, still better, with the loop, were caused by innumerable small vesicles, the contents of which were partially clear, partially opaque and partially blue-reddish. On several places furrows or prints of the teeth were imprinted, and yet on others—in the picture beside the middle line—the epithelium seemed

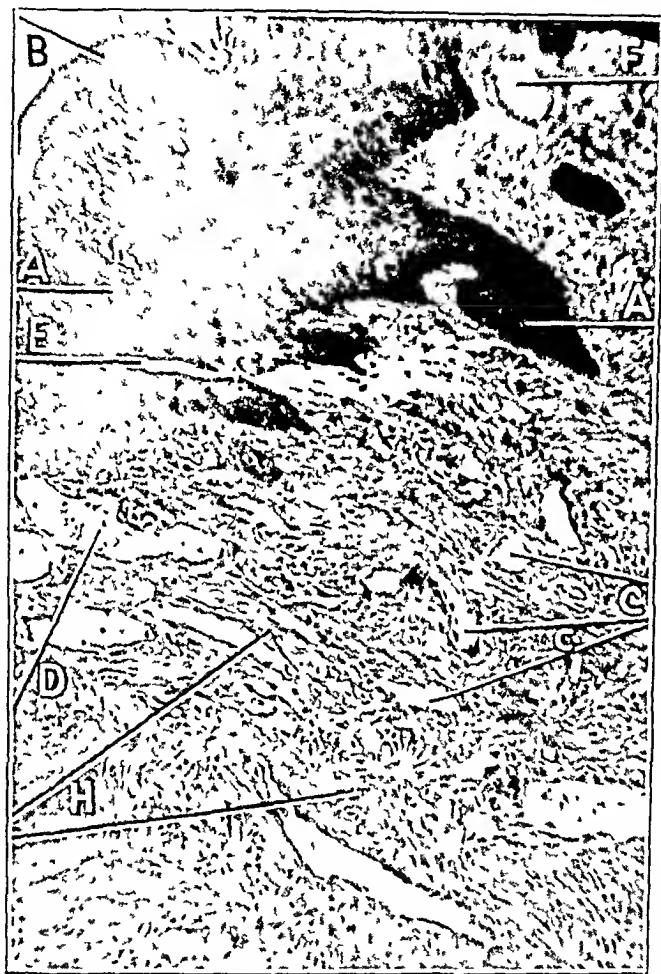


Fig. 2.—Vertical section through the epithelium, the subepithelial layer and the substance of the tongue. *A* indicates the epithelium; *B*, the cornified layer; *C*, the lacunas; *D*, a group of communicating lacunas; *E*, a lacuna in the epithelium; *F*, a subepithelial lacuna, and *H*, the septums of connective tissue between the lacunas.

to be lacking. The whole left part of the tongue was considerably enlarged. The tissue which caused the enlargement was sharply limited against the middle of the tongue; it reached backward to the circumvallate papillae, immediately beyond which was normal tongue tissue again. The same rather sharp delimitation at the margin was noted along the lateral edge.

However, a most interesting observation was made on lifting the tongue: Independent and separated from the one described by a zone of normal tissue at the lateral margin of the tongue, another, smaller, mass was to be seen under the

tongue to the left of the frenulum (fig. 1 *B*). It ran obliquely from below the left margin down toward the frenulum. It had the same appearance as the main tumor but was separated from it by normal tissue at the lateral margin of the tongue and had no connection with it.

The diagnosis was not difficult after these details had been observed. The condition was diffuse lymphangioma. The patient had no particular discomfort at that time, was satisfied with his condition and refused any specific treatment.

CASE 2.<sup>3</sup>—A 66 year old patient had noticed, supposedly only three weeks previously, a spot on the tip of the tongue which bled easily. At the time of the examination a whitish granulated and lobulated mass of about 1 cm. in diameter

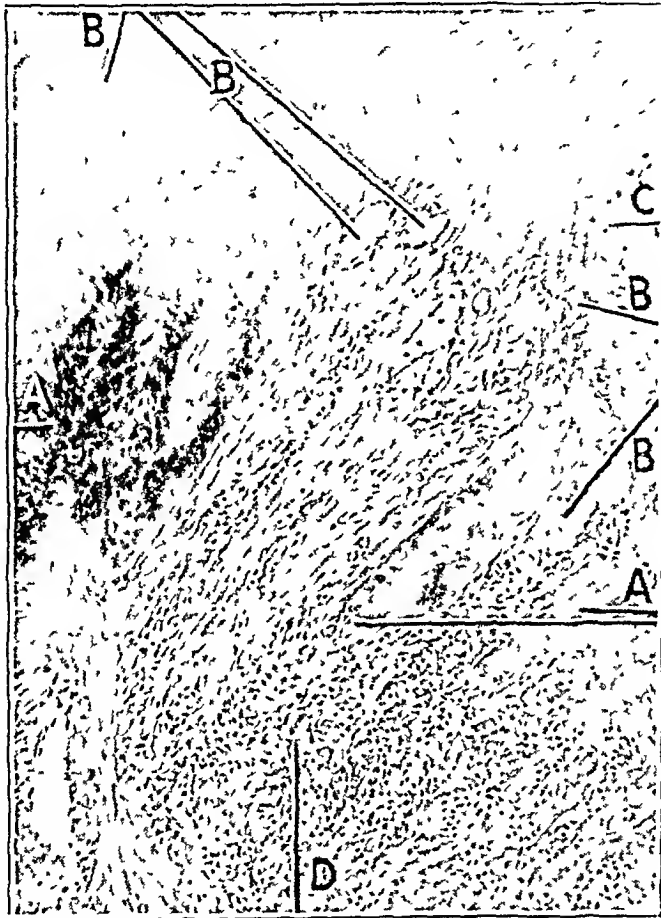


Fig. 3.—Advancing of the lacunar tissue against and into the epithelium. *A* indicates the epithelium; *B*, the lacunas; *C*, a meshwork of epithelium, and *D*, leukolymphocytic infiltration.

which did not bleed existed at the tip of the tongue. Treatment was surgical removal with the area under local anesthesia.

In this case also the clinical diagnosis was not difficult. The tumor was similar to that in case 1 but differed from it in its localization, size, consistency and appearance. The characteristic granulated surface was caused by the formation of vesicles. The condition may be classified, after what we have said, as node-shaped lymphangioma of the tongue.

3. The second case is reported by permission of Dr. W. C. Black, Head of the Department of Pathology of the University of Colorado School of Medicine.



Complete explanation is brought about by the microscopic examination, which, on account of the interest which the case presents, will be discussed in detail. A section into the tumor vertical to the epithelium of the tongue (fig. 2) shows at this site the epithelium intact but hypertrophic, irregular and cornified. Below it, in the subepithelial layer and in the substance of the tongue, where the muscles of the tongue are to be expected, a tissue is to be seen which is characterized by vast numbers of lacunas. These lacunas, which prevail in the picture, extend subepithelially, close to the epithelium and in some places into the epithelium itself. In other places, figure 3 for example, the subepithelial cavernous tissue grows between the hypertrophic processes of the epithelium into the epithelium, and the epithelium itself becomes spongy, the layers in a way loosening themselves, so that an interepithelial meshwork arises with innumerable small cavities, which almost reach to the surface.

The lacunas of the cavernous tissue (fig. 4) show various shapes and sizes, round, oval or slit-shaped. But they all show essentially the same fundamental structure: They have a thin wall and are covered inside by a one-celled row of endothelial cells (fig. 5). These cavities are in some places rare; in others, extremely numerous; they may be confluent and then spread out in labyrinthine nature. The lacunas are separated by septums of various widths, consisting of connective tissue fibers and sometimes slightly edematous tissue, which, accidentally depending on the inflammatory condition on the surface, show leukolymphocytic infiltration, and seldom a muscle fiber is to be seen.

Of interest are the contents of the cavities, which figure 4 exemplifies. They are not uniform but unique in their variances. Besides sporadic empty ones, a majority containing a homogeneous fluid is to be observed; others in addition to the fluid contain a few lymphocytes, and, finally, some, but fewer, contain blood with all its constituents, red and white blood cells.

These lacunas are in their structure and contents identical with the ones first described by Virchow and regarded as lymph vessels. The entire formation, therefore, according to this histologic observation, is to be classified as lymph vessel tumor or lymphangioma.

#### COMMENT

The findings allow the following comments:

1. The diffuse lymphangioma could be traced in our case to early youth, which fact speaks more for a congenital anlage. A traumatic or inflammatory basis is to be ruled out in both cases, for neither clinically nor microscopically are any inflammatory signs to be proved.

2. For the first time occurrence on two separate areas, or double occurrence, of lymphangioma is described, without a visible macroscopic relation between the two tumorous areas (case 1). This finding speaks for a common congenital origin of both tumors, not inflammatory in nature.

3. The occurrence of two different lymphangiomas on the same tongue gives especially interesting information on the favorite site for the development of this tumor.

The tongue develops in the third embryonal week from an anterior anlage coming from the mandibular arch, from bilateral thickenings and from a posterior paired anlage from both hyoid arches. The line of fusion between the anterior and the posterior anlage is marked in the adult by a V-shaped furrow along the line of the circumvallate papillae, in the apex of which lies the foramen caecum. It is now extremely

interesting that both lymphangiomas of the same tongue were lying within the limits of such fissures in the embryonal development beyond which they did not extend. The large main lymphangioma of the first case was limited medially by the central line of fusion between the two



Fig. 4.—Lacunae and their contents. *A* indicates a lacuna filled with serous fluid; *B*, a lacuna filled with serous fluid and some lymphocytes; *C*, a lacuna filled with red and white blood cells, and *D*, the septums between lacunas.



Fig. 5.—Lacunae under higher power. *A* indicates a lacuna; *B*, red and white blood cells; *C*, the wall (endothelial cells); *D*, the epithelium, and *E*, the inter-lacunar tissue.

thickenings of the anterior anlage and posteriorly by the embryonal fissure between the anterior and the posterior anlage of the tongue. While it spread slowly against the latter, the mass ended sharply at the former, with overhanging walls. The same was true of the small mass on the inferior surface of the tongue. It also originated from the central line of the tongue, like the superior one, but remained smaller and did not extend farther posteriorly. It must be assumed that there is some developmental arrest along the border of the embryonal tissue of the arches, which is dormant and then sometime during life takes on the peculiar lymph vessel change, forming lymphangiomas and specifically confined within definite boundaries. This observation of a double lymphangioma on the same tongue significantly supports the theory of the fissural development of lymphangiomas and of their embryonal origin.

4. The lymphangiomatous tissue substitutes the normal lingual tissue; the enlargement of the affected areas of the tongue, i. e., the macroglossia, is not brought about by hypertrophy of the lingual muscle fibers but, as Virchow previously stated, by augmentation and dilatation of the cavernous lacunas. In substantiation of this evidence muscle fibers are mostly absent or rare in the affected areas; they have become atrophic and have practically disappeared from this part of the tongue.

5. The lacunas in the cases described are filled partially with lymph and partially with blood, so that the name "hemolymphangioma" would be justified. About the development of the blood in these lacunas there are divergent opinions. While some authors assume that there is a new formation of blood vessels in such growths, others are of the opinion that there is secondary filling of the cavities with blood by erosion of blood vessels the walls of which have been thinned by the growing lymphangioma and which break through during a traumatic insult or one of the inflammatory attacks. The blood, according to the latter conception, then fills some of the dilated lymph-vascular areas. Our findings speak for the latter assumption; in none of the sections were larger blood vessels to be seen; the cavities were histologically almost without exception dilated lymph vessels, and even those which were filled with blood did not look different from the others. They were enlarged lymph vessels into which blood vessels must have eroded secondarily.

The diagnosis of these tumors, after what has been described, is confirmed or supported by the macroscopic picture of the blisters and the microscopic picture of the lacunas. In the differential diagnosis sometimes a malignant tumor could be considered, but such a growth is easily differentiated from lymphangioma by the history, the course, and the histologic examination.

The prognosis is mostly good; however, the frequent injuries to which the enlarged tongue is exposed cause a permanent danger of infection, which, even with apparent freedom from symptoms, as in our first case, makes treatment advisable.

The therapy of choice is radical excision if one is dealing with small, circumscribed tumors; with extensive, diffuse tumors the entire mass cannot be removed, but it is possible, by a combination of several

excisions of wedge-shaped sections of tissue, in different directions, to reduce the tongue so much that it has space in the oral cavity. Ignipuncture and radium therapy for such tumors have not proved as successful as they have for those of the blood vessel type.

#### SUMMARY

The clinical and histologic picture of lymphangioma of the tongue is illustrated by the presentation of 2 cases, and on the basis of the observations a contribution is furnished to the knowledge of the origin and pathogenesis of this tumor.

## OTITIS EXTERNA DIFFUSA ASSOCIATED WITH SECONDARY ANEMIA

JOHN E. ALEXANDER, M.D., ARLINGTON, VA.

While I hesitate to report on a clinical entity commonly encountered by otolaryngologists, I feel that since I learned something from these cases, they are worth at least a passing comment.

### REPORT OF CASES

CASE 1.—A 28 year old white woman complained of pain in the right ear and in the postauricular region. The bony portion of the canal of the right ear was uniformly beefy red; the drum, while slightly red, was thought to be normal, as was borne out by further clinical tests. The patient was given local treatment, such as the application of packs wet with cresatin-Sulzberger (metacresylacetate) and the exposure of the affected regions to heat. There was immediate improvement, but after several treatments the original condition recurred. After about six weeks of painstaking treatment, including the administration of a *Staphylococcus aureus* and *Staphylococcus albus* vaccine, the condition was about the same. The patient suggested that she might be anemic; after a cursory examination of her conjunctivas I thought her suggestion good. I referred her to her family physician, who reported as follows: hemoglobin 60 per cent and red blood cells 3,000,000. When questioned as to the cause of the condition of the blood, the physician replied that she did not know it although she had tried to find out; the diet was normal; the menstrual history was not unusual, and the patient was not suffering from any other pathologic condition. At any rate, after two injections of liver extract and discontinuance of local treatment, the condition began to improve and promptly disappeared. There has been no recurrence to date, after an interval of four months.

CASE 2.—A 12 year old white boy complained of pain in the left ear and swelling of the glands of the neck. Examination revealed a large furuncle near the external auditory meatus on the lower wall. This was promptly incised and drained. A moderate amount of frank pus was obtained. This condition subsided. Two days later the patient returned, complaining of the persistence of pain. The incised furuncle was well on the road to recovery, but the skin over the bony portion of the canal was diffusely red and exquisitely tender; hence a diagnosis of otitis externa diffusa was added. Local treatment was employed for a few days and the furuncle disappeared, but the diffuse inflammation of the canal grew worse. Without waiting for the patient to suggest it in this instance, I referred him to a general practitioner, who reported secondary anemia, with a hemoglobin content of 60 per cent and a red blood cell count of 3,000,000. This proved to be a nutritional type of secondary anemia. After five days of oral administration of liver extract the condition had disappeared and has not recurred in three months.

CASE 3.—A 68 year old white woman presented herself, complaining of pain in both ears of three days' duration, and gave a history of an inflammation of both aural canals one year previously that lasted one month with recurrences. Both canals were diffusely red, especially over the bony portions. I finally per-

suaded the patient to have a blood count done, although she remonstrated that she had recently had a general check-up and that if she had had anemia her doctor would certainly have detected it. Her report came back, "very mild secondary anemia," with a hemoglobin value of 70 per cent and a red blood cell count of 3,000,000. At any rate, the patient was given a course of treatment with liver extract by mouth as well as the usual local therapy. The condition subsided in one week and has not appeared since, after an interval of three months. This patient, according to symptoms and signs, had by far the worst involvement of the three. The anemia in this patient was most probably also of the nutritional type.

#### CONCLUSION

While the local treatment for this disease is fairly well standardized, I wonder if some of the more protracted or obstinate examples might not be traceable to relatively mild secondary anemia. At least, judging from my own meager experience, I want a red cell count and a hemoglobin determination made in my future cases of otitis externa diffusa.

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# Clinical Notes; New Instruments and Technics

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## A POSITIVE METHOD FOR ABLATION OF SEPTO-TURBINAL SYNECHIAE

CHARLES FIRESTONE, M.D., SEATTLE

Adhesions arising between the nasal septum and the turbinate bones are ordinarily the result of trauma, operative or otherwise. On rare occasions ulcerative lesions arising in the course of systemic diseases produce synechiae. It is my experience that of those adhesions occurring as a result of trauma, the postoperative are the most common. Owing to the turgescence of the lower turbinate bones and the increased width of the septum at its base, narrowing the nasal channel in that location, synechiae often occur between these two structures after operative procedure. One not infrequently, however, encounters adhesions higher, in the region of bony septal spurs, and between the septum and a bulbous middle turbinate. The usual history in the latter cases is that a diagnosis of sinus disease had been made and the area subjected to instrumentation, operative or applicative.

Synechiae, per se, while constituting abnormal structures, are harmless as structural pathologic entities. They, however, produce symptoms of which the patient is conscious. To the patient they give the feeling of the presence of something foreign in the nasal chamber. This feeling is imparted to him by contact of two areas normally separated. He at times interprets them by his complaint of the feeling of a foreign body in the nasal channel, even if these adhesions are small. According to the extent of the adhesions the patient experiences a lesser or greater sensation of fullness in his nose, which blowing only partially relieves, and the symptom complex of obstructed sinus drainage with its attendant train of symptoms, the severity of which is more or less directly proportional to the location and extent of involvement. In the region of these synechiae one generally finds an accumulation of mucus, sometimes viscid and free and sometimes adherent to the synechiae by the crusting of the layer adjacent to the scar tissue forming the adhesions.

For some reason, the treatment of synechiae has not received adequate attention in rhinologic textbooks. If the subject is mentioned at all, the treatment advised is separation of the adhesions with subsequent applications of ointments or other medicaments, in an effort to keep the tissues from reestablishing contact and ultimately readhering. In my cases this method of treatment has always required prolonged observation, and the results have often been unsuccessful. Each office visit necessitates an application of medicaments, and these applications tend of themselves to induce factors favorable to the reestablishment of the adhesion, as they disturb the healing processes.

In consequence of these experiences, I have devised a procedure which in my hands has shortened the period of treatment and proved wholly successful. The procedure follows:

The nasal chamber to be operated on is thoroughly anesthetized by the topical application of a 5 per cent solution of cocaine hydrochloride to which 15 drops of epinephrine hydrochloride to the drachm (3.88 Gm.) has been added. Into the septal and the turbinate adhesive area is then injected a 1 per cent solution

of procaine hydrochloride and epinephrine hydrochloride (epinephrine hydrochloride 10 drops to the ounce [30 cc.]) for a considerable distance beyond their borders, injection into each of these areas being made separately. The adhesion is then severed close to the septum, the eschar being left adherent to the turbinate mucosa. The eschar, together with a crateriform portion of the mucosa, is completely excised from the turbinate mucosa. This crater is then curetted all the way down to the turbinate bone so as to produce an elliptoid crater, the longer axis of which is in a vertical position. Next, the mucosa is undermined sufficiently to allow loosening and approximation of the mucus-surfaced lips of the prepared elliptic crater, and is sutured. This produces a linear scar in place of the original irregular scar and of the elliptic one resulting from the operation. This linear scar is vertical as a result of the elliptoid craters, having been prepared vertically.

I have not always found it possible to obtain a sufficient flap on the septum, as the septal mucosa is thinner and more taut. The septal scar, therefore, becomes an individual problem, and is repaired by flap if it is feasible; when this is not feasible, it is left to heal, as described later. In the case of a bony spur, I separate a flap of the mucosa, excise the scar and by submucous resection remove the spur and then lift the flap, to cover the denuded area. If sufficient mucosa has not been obtained by this procedure, a portion of the bony maxillary crest of the septum is removed after the mucosal flap has been separated, and approximation is thus obtained. This flap is always cut horizontally with a view to having the resultant linear scar at cross angles to the linear scar on the opposing turbinate bone. The linear scars obtained should, theoretically at least, touch at only one point. This procedure is not always practical and, indeed, in my hands not feasible for some septal locations. When this is the case, the septal scar is not interfered with, but is allowed to heal. In instances in which the synechia is between the middle turbinate bone and the septum, the synechia is separated close to the septum, and the mucous covering of the middle turbinate bone undermined and the bony middle turbinate bone crushed, if necessary, to obtain laxity and reapproximation of the mucous edges.

The procedures described so far would be, in my opinion, in themselves an improvement over discussion of the synechia and subsequent medicamentary application as generally practiced, even if this discussion were to stop here. However, these methods will not succeed in every case, as smaller punctal adhesions may form. The desideratum is to keep the two formerly adherent surfaces separated during the healing. Complete nasal packs are cumbersome and not well borne, for this period, and partial packs have a tendency to move about or be dislodged from the location for which they are intended.

I accomplish this separation by introducing into the nasal channel a thin piece of celluloid to both sides of which has been applied a 5 per cent boric acid ointment. It is of sufficient length and height to insure its keeping the two formerly adherent areas separated during the healing. It rests on the floor of the nasal channel. It must be big enough to intervene completely between the two repaired surfaces, even when it is displaced by shifts in body position and by nose blowing. It is retained in the nose for three weeks, during which period it is inspected twice weekly, removed, cleaned and reshaped if necessary. The septal and the turbinal wound undergo complete healing in this period, and chances for the recurrence of the synechia are completely eliminated.

When I find it impractical to produce a linear scar as outlined, I sever the synechia close to the turbinate bone, allowing the eschar to adhere to the septum. I then remove the eschar close to the septal wall and introduce the celluloid strip.



If the synechial area is extensive, preliminary packing may be necessary. The introduction of the separating celluloid strip may then have to be delayed twenty-four to forty-eight hours.

#### CONCLUSIONS

1. The treatment of septoturbinal synechiae by merely severing them is inadequate.
2. The procedure of excision of the eschar and production of linear scars at cross angles to each other by means of flaps is the desideratum, as it reduces the chances for readhesions to form.
3. The introduction of a medium that separates the hitherto adherent areas and the retention of that medium during the healing render the reforming of synechiae impossible.

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# Progress in Otolaryngology

## Summaries of the Bibliographic Material Available in the Field of Otolaryngology

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### PERORAL ENDOSCOPY

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AND

F. JOHNSON PUTNEY, M.D.

PHILADELPHIA

### BRONCHOSCOPY

*Anatomy of the Bronchi.*—With recent advances in the knowledge of pulmonary diseases and with the necessity for correlating of findings by the roentgenologist, the internist, the bronchoscopist and the thoracic surgeon, there is need for a more comprehensive description of the structure of the bronchi, particularly for one which will permit visualization of their distribution to the pulmonary tissue. There has been some confusion due to different interpretations of nomenclature by different writers. Neil, Gilmour and Gwynne<sup>1</sup> said they considered it important to recognize as different entities those branches which supply separate pulmonary segments and which bear a different relationship to the chest wall. Instead of designating them tertiary bronchi they suggested the term segmental bronchi. There appears to be no reason, either anatomic or clinical, for subdividing a main bronchus into two or more parts. Anatomic and clinical recognition is readily established on the basis of the bifurcation and the openings of the various vestibules and branches. There is no practical use in giving names to the subdivisions beyond the segmental bronchi. A list of the segmental bronchi and the larger subdivisions in the sequence in which they leave the tracheobronchial tree is given.

*Acute Laryngotracheobronchitis.*—In a report of 6 cases of acute infective laryngotracheobronchitis, Font and Ortiz<sup>2</sup> recorded the clinical progress of the patients. Three died. *Staphylococcus aureus haemolyticus* was found in all 3 instances. The behavior in their cases was not unlike that noted in cases of infection produced by *Streptococcus*

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1. Neil, J. H.; Gilmour, W., and Gwynne, F. J.: The Anatomy of the Bronchial Tree, *Brit. M. J.* **1**:495 (March 11) 1939.

2. Font, J. H., and Ortiz, A.: Acute Infective Laryngotracheobronchitis in Puerto Rico, *Puerto Rico Health Bull.* **3**:109, 1939.

haemolyticus. The onset commonly was unassociated with any previous acute infection of the upper respiratory tract, and the patients did not seem ill until the appearance of croup, cough and dyspnea. Therapeutic procedures indicated are the following: maintaining an adequate airway, combating dehydration and keeping the patient's resistance at the highest possible level.

Three cases of acute laryngotracheobronchitis in which recovery occurred were reported by Evans.<sup>3</sup> In 1 the condition was due to *Str. haemolyticus* and in the remaining 2 to *Staph. albus*. In the cases of staphylococcic infection, bacteriophage was instilled into the trachea at frequent intervals and soon removed by suction. Each instillation of the fluid induced a paroxysm of coughing with expectoration of quantities of thick, viscid purulent secretion. Other important essentials in the treatment of these patients were: constant and competent special nursing, humidification of the air, maintenance of an adequate airway by tracheotomy, frequent aspiration of secretion through the cannula and bronchoscopic removal of crusts when indicated.

Difficulty in maintaining an adequate airway in cases of acute laryngotracheobronchitis, even after tracheotomy, commonly results from obstruction of the trachea and bronchi with thick or inspissated secretions. In Cassidy's<sup>4</sup> case, tracheotomy, the employment of an oxygen tent, humidification of the air, intratracheal instillation of saline solution with ephedrine and aspiration through the tracheal cannula were not effective, and the bronchoscope was resorted to for removal of obstructing crusts. A total of 37 bronchoscopic aspirations were performed over a period of thirteen days. The patient made a complete recovery.

The treatment of acute laryngotracheobronchitis was discussed by Galloway,<sup>5</sup> who reported 10 cases of this infection in which cannulation was required, in 2 of which death occurred. He stated the opinion that the fatal termination is due to cardiac and general exhaustion which occur after the bronchial tree has been blocked by edematous and inflammatory mucosa, with thick adherent secretions producing atelectasis. Early tracheotomy and bronchial aspirations are indicated, and as an adjunct postural drainage has proved especially valuable. With the head of the patient lowered the bronchial lumen is kept free of secretion and plugs by the use of suction applied by a catheter through the trache-

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3. Evans, M. C.: Acute Laryngotracheobronchitis: Report of Three Recovered Cases, *Ann. Otol., Rhin. & Laryng.* **48**:216 (March) 1939.

4. Cassidy, W.: Acute Laryngotracheobronchitis, *Arch. Otolaryng.* **29**:857 (May) 1939.

5. Galloway, T. C.: Postural Treatment of Acute Laryngotracheobronchitis, *J. A. M. A.* **112**:1566 (April 22) 1939.

otomy tube. In the cases reported, instillation of a warm sodium bicarbonate or epinephrine solution removed obstructing crusts satisfactorily.

*Laryngeal Stridor.*—In a study of 30 case histories of infants with stridorous breathing, Bowman and Jackson<sup>6</sup> found supraglottic obstruction to inspiration due to deformity or flaccidity of the epiglottis, arytenoids and aryepiglottic folds. Although 21 infants were reported, on the basis of roentgen studies, as having some enlargement of the thymus gland, only 5 were definitely improved by roentgen therapy. In 3, there was found congenital malformation of the larynx. Satisfactory study of a child with stridor should include roentgen examination of the neck and chest in both planes and an endoscopic examination of the larynx and trachea.

*Anesthesia.*—Endoscopic procedures may be satisfactorily performed with a minimum of discomfort if there is adequate anesthesia. Putney<sup>7</sup> outlined the technic of administering local anesthesia for peroral endoscopic procedures. He expressed preference for topical applications of pontocaine hydrochloride, 1 per cent, to the piriform sinuses and for instillation of larocaine hydrochloride, 2 per cent, into the larynx and trachea. The importance of the time element, of the amount of solution used and of placing the medication in the desired locality was stressed. In treating laryngeal conditions it is desirable to fractionate the dose. Sedatives are valuable aids and should be used for all diagnostic bronchoscopic examinations and for bronchoscopic removals of foreign bodies. Children tolerate large doses of morphine remarkably well.

*Indications for Direct Laryngoscopic Procedure.*—In a discussion of the indications for direct use of the laryngoscope, Jackson<sup>8</sup> referred briefly to the early contributions in the development of this procedure. Direct use of the laryngoscope affords the only means of examining the larynx of infants and young children. The presence of symptoms referable to the larynx of a child is therefore an indication for a direct laryngoscopic procedure for diagnosis and often for treatment. The adults for whom direct examination is indicated are those in whom the larynx cannot be visualized properly by mirror laryngoscopic examination and those requiring additional instrumental manipulation, such as removal of tissue for biopsy, removal of a growth or foreign body and dilation. Benign and malignant growths, vocal nodules, contact ulcer,

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6. Bowman, J. E., and Jackson, C. L.: Chronic Stridor in Infancy, *J. Pediat.* **15**:476 (Oct.) 1939.

7. Putney, F. J.: Anesthesia in Peroral Endoscopy, *Laryngoscope* **49**:55 (Jan.) 1939.

8. Jackson, C. L.: Indications for Direct Laryngoscopy, *Ann. Otol., Rhin. & Laryng.* **48**:926 (Dec.) 1939.

laryngeal tuberculosis and other conditions were discussed from the standpoint of direct laryngoscopic procedure for diagnosis and treatment.

*Beriberi.*—Hoarseness and weakness of the voice, sometimes aphonia, are among the frequent symptoms of infantile beriberi. Because of insufficient observation of the larynx and considerable confusion concerning the laryngeal lesions in infantile beriberi, Alcantara and de Ocampo<sup>9</sup> carried out clinical studies on a group of infants which included 37 with beriberi. Direct laryngoscopic procedure was performed in all cases. Observations on the laryngeal lesions found were summarized by the investigators as follows: Five patients with acute cardialgic beriberi, in whom the impairment of voice was slight, showed only slight congestion of the vocal cords, the motility being normal. All the rest had impairment of motion of the vocal cords. The right vocal cord was paretic or could not move completely to the median line in 4 patients, stayed immobile in the middle in 9 and assumed a cadaveric position in 3. The left vocal cord was paretic in 5 patients, completely immobile in the median line in 9 and cadaveric in 1. The vocal cords were bilaterally affected in 3 patients. In some of the infants the paretic vocal cord appeared at a lower level than the normal cord. Alcantara and de Ocampo expressed the belief that impaired motility of the vocal cords should be added to the already recognized factors for the diagnosis of infantile beriberi. In cases in which beriberi and acute infection of the respiratory tract are thought to coexist, the motility of the cords is of help in determining whether both are present and what degree of deficiency of vitamin B<sub>1</sub> exists in the child.

*Foreign Body.*—Stauffer<sup>10</sup> reported 19 cases of the presence of nutshells and kernels in the bronchus. The foreign objects were removed in all but 3 cases; in 2 cases the foreign body was coughed out before the bronchoscope was used, and in the other permission for the operation could not be obtained. Most of the patients were under 3 years of age. After the initial accident there is usually an interval in which the patient is free from symptoms, a period followed by severe illness. Unless the significance of the accident is appreciated and removal of the foreign body promptly performed, obstructive emphysema is followed by drowned lung, with complications of abscess of the lung or empyema resulting later. In this group, death occurred in 2 cases; in 1 bronchoscopic procedure was refused and an autopsy revealed a peanut in the bronchus, together with atelectasis, and in the other the

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9. Alcantara, V. C., and de Ocampo, G.: The Larynx in Infantile Beriberi, *Arch. Otolaryng.* **30**:389 (Sept.) 1939.

10. Stauffer, F. L.: Nutshells and Kernels in the Bronchus, *Rocky Mountain M. J.* **36**:93 (Feb.) 1939.

postoperative course was complicated by burns over the face, neck and chest and at autopsy atelectasis of both lungs was found.

In reporting the successful removal of peanuts from lobar bronchi of a group of 8 patients, Gerlings<sup>11</sup> emphasized the importance of the clinical and roentgenologic recognition of lobar emphysema. The changes are not so distinctive as those noted in obstructive emphysema of an entire lung, resulting from partial obstruction to a main bronchus.

Gill<sup>12</sup> reported 36 cases of the presence of vegetable foreign bodies in the tracheobronchial tree, in which the objects were removed bronchoscopically with the exception of 2 cases in which removal was through the tracheotomy wound and 4 in which the object was coughed out. One death, that of a moribund child in whom the foreign body had been present for three months, could not in any way be attributed to bronchoscopic procedure. Tracheotomy was necessary in 9 instances. Almost half of the foreign bodies were peanuts, but the most severe reactions were noted in the 3 children in whom the obstructive bodies were pinto beans.

In a discussion of the nature and significance of pathologic changes consequent on prolonged lodgment of foreign bodies in the lower airway, Butler and others<sup>13</sup> reported in detail their findings in 9 cases in which a foreign body was proved to be present. In 5 cases, one of the two common causes of delay in diagnosis of presence of a foreign body was operative, namely overlooking or disregarding a clearcut history of foreign body accident. The bronchoscope was employed in 8 cases but in only 1 was the foreign body successfully removed. Acute nonsuppurative pneumonitis and localized abscess each occurred but once. Contralateral bronchopneumonia occurred twice. Chronic bronchiectasis was demonstrated in 5 cases. Bronchostenosis occurred but once. Empyema, a common complication of pulmonary suppuration, occurred in 3 instances. In 1 case abscess of the brain occurred as a terminal complication in bronchiectasis due to a retained but unsuspected foreign body. Particular emphasis should be placed on two pathologic conditions, acute suppurative pneumonitis and chronic suppurative bronchiectasis. One or both of these were observed in 7 of the 9 patients. It is reasonable to believe that they are evolutionary phases of the same entity and that bronchiectasis will probably occur in any patient who has survived prolonged obstruction of the air

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11. Gerlings, P. G.: Foreign Bodies in the Air Passages Causing Unilobar Obstructive Emphysema, *J. Laryng. & Otol.* **34**:23 (Jan.) 1939.

12. Gill, E. G.: Management of Organic Foreign Bodies in Trachea and Bronchi of Children, *Virginia M. Monthly* **66**:275 (May) 1939.

13. Butler, E. F.; Lincoln, N. S.; Deegan, J. K., and Horton, R.: The Late Results of Foreign Bodies Long Retained in the Lower Airways, *Ann. Otol., Rhin. & Laryng.* **48**:817 (Sept.) 1939.

passages by an aspirated foreign body. It therefore follows that once pulmonary suppuration has become established, removal of the foreign body is no longer adequate to prevent or cure chronic disease. Extirpation of the damaged lobe becomes a requisite for cure.

*Diagnosis.*—The bronchoscopist who has had opportunity to visualize the respiratory passages and observe patients with bronchial obstruction often places a different interpretation on certain symptoms and physical signs observed in patients with acute diseases of the respiratory tract. Gittins<sup>14</sup> referred to the frequent diagnostic misunderstandings occurring in judgments on partial bronchial obstruction. The symptoms and signs produced by inhalation of a foreign body are entirely different from those produced by the common descending infections of the respiratory tract. Bronchopneumonia is often atelectasis secondary to mechanical obstruction of a bronchus by masses of mucus. In such cases the infection and the type and virulence of the organisms are frequently of less importance than the obstruction to the bronchus. Bronchoscopic aspiration not only is of value in diagnosis but has a definite place in the treatment of many of those conditions which often are diagnosed as bronchopneumonia.

The history is of great importance, especially when the patient is a child. The sudden onset of respiratory symptoms in a child previously well should immediately suggest foreign body. In many instances of so-called pneumonia and pulmonary abscess the condition might have been prevented if attention had been given to the possibility of foreign body as the probable reason for the sudden onset of respiratory symptoms. Gittins concluded by stating that closer cooperation of the general physician, the internist and the pediatrician with the bronchoscopist in the diagnosis and treatment of acute obstruction, inflammation and infection of the respiratory tract will surely result in the benefit of all concerned, but especially the benefit of infants and young children, who are so prone to suffer seriously from acute involvement of the chest.

The term "unresolved pneumonia" is usually employed loosely and commonly refers to the persistence of pulmonary changes after an infection, presumably pneumonia, has failed to respond to treatment and has continued unchanged well beyond the time of self limitation of conditions erroneously considered to be pneumonia. McGibbon, Baker-Bates and Mather<sup>15</sup> examined bronchoscopically 38 patients whose conditions were incorrectly diagnosed, on the basis of roentgen examination and clinical observations, as unresolved pneumonia. Eight of

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14. Gittins, T. R.: The Acute Chest from the Bronchoscopic Standpoint, *Ann. Otol., Rhin. & Laryng.* **48**:1087 (Dec.) 1939.

15. McGibbon, J. E. G.; Baker-Bates, E. T., and Mather, J. H.: Importance of Bronchoscopy in Unresolved Pneumonia, *Lancet* **2**:183 (July 22) 1939.

these were found to be suffering from bronchial carcinoma, 1 from an extrabronchial tumor of unknown character, 2 from impacted non-opaque foreign body, 5 from bronchiectasis, 1 from inflammatory stenosis of a bronchus, 2 from pulmonary abscess and 1 from enlarged bronchial lymph nodes. In 18 children who exhibited varying degrees of incomplete bronchial obstruction, secretion was found. From these data it may be seen that although the clinical and roentgenologic findings suggested unresolved pneumonia, the common lesion was caused by bronchial obstruction. The conditions which are diagnosed as unresolved pneumonia commonly are those in which there is partial bronchial obstruction with secondary changes distal to it. In cases of complete stenosis there is evidence of lobar or segmental collapse and the findings differ greatly from those in unresolved pneumonia. The age of patients is important in connection with this group of diseases. In children and young adults, bronchial obstruction is more often due to foreign body, secretion or enlarged lymph nodes. In adults, bronchial carcinoma is a common finding. When contemplating a diagnosis of unresolved pneumonia one must recall that the common secondary results of bronchial obstruction are pneumonitis, collapse, bronchiectasis, pulmonary abscess and gangrene. If, therefore, a patient whose condition is diagnosed as unresolved pneumonia does not exhibit progressive improvement by clinical and roentgen examination, the bronchoscope should be employed.

The outlook for persons suffering from various pulmonary disorders has improved remarkably during the past decade. This is the result of improved diagnostic procedures and therapeutic measures. Arbuckle and Stutsman<sup>16</sup> emphasized the importance of team work in the field of pulmonary diseases, notably in thoracic surgery. While physical examination and roentgen studies are necessary for the demonstration of pulmonary disorders, in many instances endobronchial inspection and study of specimens of tissue and secretions removed bronchoscopically are necessary to establish an etiologic diagnosis. The excellent results secured by bronchoscopic measures in the treatment of pulmonary abscess indicate the need for considering this method when outlining treatment in such a case. A number of case reports are cited to emphasize the importance of the use of the bronchoscope in diagnosis and treatment of various pulmonary diseases.

The attempt to use bronchoscopic procedure alone, without conscientious teamwork, has been, in the opinion which Orton<sup>17</sup> expressed,

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16. Arbuckle, M. F., and Stutsman, A. C.: *The Bronchoscopist and the Thoracic Surgery Team*, J. A. M. A. **133**:1394 (Oct. 7) 1939.

17. Orton, H. B.: *Bronchoscopy as an Aid in Treatment*, J. Indiana M. A. **32**:683 (Dec.) 1939.



a dominant factor in producing confusion as to its real value in the diagnosis and treatment of pulmonary diseases. The internist or pediatrician who first sees the patient must decide if the bronchoscope is to be employed. Bronchoscopic removal is the only method to be considered for the extraction of foreign bodies lodged in the tracheobronchial tree. Obscure diseases of the chest should have the benefit of bronchoscopic investigation. Use of the bronchoscope should be a routine procedure in cooperation with the thoracic surgeon and internist.

*Allergy.*—In a report on the occurrence of obstructive atelectasis in 7 allergic children, Friedman and Molony<sup>18</sup> discussed the etiologic factors. These included spasm of the bronchial musculature, thickening of the bronchial and bronchiolar walls, edema, hyperplasia, hypertrophy and cellular infiltration, the presence of thick, tenacious mucus and paradoxical collapse of the bronchi during expiration. Treatment is concerned first with giving immediate relief to the patient and secondly with the prevention of recurrence. The treatment is of interest to bronchologists, for if the atelectasis persists in spite of the customary employment of postural drainage, of expectorants and of epinephrine hydrochloride, bronchoscopic aspiration is the method of choice. Repeated aspiration may be necessary before adequate ventilation of the bronchial tree is secured. Friedman and Molony suggested the possibility of recurrent atelectasis as a precursor of bronchiectasis.

Chang<sup>19</sup> reported 2 cases of acute laryngeal obstruction proved to be definitely allergic in origin, with specific sensitivity to milk. In the first case the allergic manifestations involved the larynx and the gastrointestinal tract. In the second case the tracheobronchial tree as well as the larynx was involved. There was edema of the mucosa of the trachea and bronchi, together with much thin mucous exudation. In both cases tracheotomy was necessary for relief of dyspnea. Chang emphasized the importance of considering the possibility of allergy as an etiologic factor in the management of all patients with laryngeal obstruction.

*Rupture of the Bronchus.*—A case of rupture of the left main bronchus from external trauma, in which recovery occurred, was reported by Jones and Vinson.<sup>20</sup> This usually fatal condition was promptly recognized and immediate treatment given for the bilateral tension pneumothorax and mediastinal emphysema. Suppuration did

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18. Friedman, T. B., and Molony, C. J.: Role of Allergy in Atelectasis in Children, *Am. J. Dis. Child.* **58**:237 (Aug.) 1939.

19. Chang, C. S.: Allergy of the Larynx with Report of Two Cases, *Ann. Otol., Rhin. & Laryng.* **48**:783 (Sept.) 1939.

20. Jones, F. W., and Vinson, P. P.: Nonfatal Rupture of the Left Main Bronchus from External Trauma, *Surgery* **5**:228 (Feb.) 1939.

not develop, but complete atelectasis of the left lung occurred. Bronchoscopic examination revealed bronchial stenosis due to stricture and a healing area of necrosis on the posterior wall of the left main bronchus. Five months after the accident there was no distal pulmonary infection, and the patient was described as being quite well.

*Pulmonary Suppuration.*—Bronchiectasis is commonly considered as an anomaly involving the lower lobes or a middle lobe. The occurrence of bronchial dilatation in an upper lobe usually suggests a tuberculous process. Rilance and Howlett<sup>21</sup> observed 3 patients with a condition diagnosed as nontuberculous bronchiectasis. In these patients there was no evidence of tuberculosis, and definite bronchiectasis was demonstrated after instillation of iodized oil. Rilance and Howlett said they were agreed that either an active or a healed tuberculosis is the causative factor in the vast majority of cases of bronchiectasis of the upper lobe.

#### NEOPLASMS

*Papilloma.*—The extension of papilloma of the larynx into the trachea is not uncommon; extension to the tracheal bifurcation and into a bronchus is not so frequently observed. In the case reported by Patterson<sup>22</sup> tracheotomy was performed for relief of obstructive laryngeal dyspnea and a direct laryngoscopic procedure was frequently done to remove a papilloma of the larynx. The lesion ultimately ceased to recur, and the larynx appeared normal. Five months later, the patient returned so dyspneic and cyanotic that asphyxiation appeared imminent, this in spite of an unobstructed tracheotomy tube in the trachea. Bronchoscopic examination through the tracheal fistula revealed papillomas obstructing the trachea and the left bronchus. Treatment consisting of frequent removals by means of the bronchoscope, the employment of a cane-shaped tracheal cannula and constant attendance of trained personnel to keep the airway open was finally rewarded by nonrecurrence of the growths, return of a good voice and a normal larynx.

Vigi<sup>23</sup> reported the occurrence of two successive attacks of collapse of the lower lobe of the right lung in a patient aged 16 years who was suffering from laryngotracheal papillomatosis. A moderate pulmonary hemorrhage preceded the initial pulmonary collapse. In the discussion

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21. Rilance, A. B., and Howlett, K. S., Jr.: Nontuberculous Upper Lobe Bronchiectasis, *Am. Rev. Tuberc.* **40**:204 (Aug.) 1939.

22. Patterson, E. J.: Multiple Papilloma of the Larynx, Trachea and Left Bronchus in a Child, *Ann. Otol., Rhin. & Laryng.* **48**:1080 (Dec.) 1939.

23. Vigi, F.: Two Successive Attacks of Massive Collapse During Laryngotracheal Papillomatosis, *Arch. ital. per le mal. d. trachea-bronchi-esophago* **7**:39 (Jan.-March) 1939.

of the possible cause of the collapse it was pointed out that the papilloma involved only the larynx and the upper part of the trachea. The opinion was expressed that the collapse of the lower lobe may have resulted from reflex active contraction of the pulmonary musculature; however, the decreased pulmonary ventilation produced by the papillomatous obstruction of the larynx and upper part of the trachea could not be excluded as a contributory factor.

*Mixed Tumor of the Trachea.*—Mixed tumors of the trachea are extremely rare. In the case reported by Gerlings and Roegholt,<sup>24</sup> that of a woman aged 50, there was a history of difficulty in breathing of long standing, which was aggravated after an influenzal attack eighteen months before the patient's admission to the hospital. Marked dyspnea with stridor and cyanosis on the slightest exertion was observed. There was no dysphagia. Mirror laryngoscopic examination revealed a smooth swelling arising from the posterior wall of the trachea and occupying the greater part of the lumen. A lateral roentgenogram of the neck showed a large semiglobular mass in the upper part of the trachea, apparently arising from the posterior wall. The most probable diagnosis was a benign tumor. The growth was removed through the tracheostomy opening. It separated readily from the surrounding tissues and exhibited all the clinical appearances of a benign lesion. The histologic studies revealed a typical mixed tumor such as is found in the parotid gland.

Howarth<sup>25</sup> reported a case of mixed tumor of the trachea occurring in a man aged 69. The patient had complained of gradually increasing dyspnea for several months. Mirror laryngoscopic examination revealed a smooth, rounded, shiny swelling immediately below the level of the vocal cords, which was more prominent on the right side. Because of the marked dyspnea a low tracheotomy was performed. The patient was kept under observation for a time and then was lost sight of, to reappear about two years later. At that time the subglottic tumor presented an appearance similar to that noted previously except that the growth seemed to have increased in size. Removal was decided on, and the trachea was opened anteriorly in the midline. The growth was readily separated from the surrounding tissues. The histologic studies of the tumor suggested an adenoma closely resembling a mixed salivary tumor, often found in the parotid gland.

*Carcinoma of the Trachea.*—Two cases of carcinoma of the trachea were reported by Cann.<sup>26</sup> In both the patients were women. The

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24. Gerlings, B. G., and Roegholt, M. N.: Mixed Tumor of the Posterior Wall of the Trachea, *J. Laryng. & Otol.* **54**:194 (April) 1939.

25. Howarth, W.: Mixed Tumor of the Trachea, *J. Laryng. & Otol.* **34**:205 (April) 1939.

26. Cann, R. J.: Basal Celled Carcinoma of Trachea, *J. Laryng. & Otol.* **54**:197 (April) 1939.

symptoms were stridor, dyspnea, unproductive cough and on one occasion slight hemoptysis. There were no vocal disturbances. In neither case was anything observed by mirror laryngoscopic examination. In both the diagnosis was made by biopsy, the tissue in 1 case having been removed bronchoscopically and in the other at the time of tracheotomy. The extent of involvement of the tumor was clearly shown by roentgen examination after instillation of iodized oil into the trachea. In 1 of the cases treatment was by irradiation therapy and in the other by teluradium. In both cases the tumor has apparently disappeared and the tracheal obstruction has been relieved.

In a study of carcinoma of the trachea, carried out for the purpose of correlating the pathologic observations with the symptoms and treatment, Olsen<sup>27</sup> added 9 cases that had not been previously reported. The symptoms, which are caused chiefly by certain mechanical factors, are dyspnea, which may be paroxysmal, cough and stridor. Later, hemoptysis, expectoration, bronchopulmonary infection and dysphagia may result. While the history, symptoms, signs and roentgen findings are important in diagnosis, tracheoscopic examination and biopsy are essential in practically every case. The prognosis is generally unfavorable. Treatment is difficult and unsatisfactory. The diagnosis commonly is made late. Surgical resection of the trachea, local removal and cauterization with surgical diathermy carried out through a bronchoscope or through the tracheotomy wound appear to be the most effective methods of treatment.

*Cylindroma*.—Six cases of cylindroma, in 4 of which the lesion occurred in the tracheobronchial tree, were reported by Kramer and Som.<sup>28</sup> When observed bronchoscopically these tumors are distinguished by an encapsulated, lobulated, grayish-appearing mass with an intact mucosa. The tumor is sessile and slow growing, and produces destruction by pressure as well as by actual invasion. Distant metastasis and transition to carcinoma are rare, but there is a marked tendency toward local recurrence. Histogenesis of this type of mixed tumor was discussed. Endoscopic removal can be satisfactorily accomplished by electrocoagulation, as demonstrated by Kramer and Som, but if a tendency toward recurrence appears radiotherapy offers valuable aid in treatment.

*Fibrolipoma*.—Benign tumors of the bronchi are no longer of sufficient rarity to warrant in themselves special interest; certain types are, however, not commonly met with. A case of bronchial fibrolipoma in

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27. Olsen, A. M.: Carcinoma of the Trachea, Arch. Otolaryng. **30**:615 (Oct.) 1939.

28. Kramer, R., and Som, M. L.: Cylindroma of the Upper Air Passages, Arch. Otolaryng. **29**:336 (Feb.) 1939.

a man aged 48 was reported by McGlade.<sup>29</sup> The onset of the patient's illness five weeks before consultation was considered as an attack of pneumonia. The thoracic symptoms never completely cleared up, and the patient was referred for an examination of the chest, which was to include bronchoscopic study. A roentgenogram of the chest revealed evidence of obstructive atelectasis of the left lung. At the time of bronchoscopic examination a rounded mass found completely occluding the left bronchus was removed. It appeared smooth and was not ulcerated. It was 5 cm. in length. Immediately after removal of the tumor the patient was able to take a deep breath, and he commented that he had been unable to do so for over a year. It is interesting to note that in this case wheezing respiration had been present for some time, but apparently no particular significance had been attached to it.

*Myoblastoma.*—In a case of myoblastoma of the bronchus reported by Kramer,<sup>30</sup> the growth completely occluded the bronchus to the lower lobe of the right lung, producing a lobar atelectasis. There were symptoms and signs of pulmonary suppuration, namely, fever, cough, purulent expectoration and clubbing of the finger tips. The growth appeared pinkish gray and was pedunculated. It was removed bronchoscopically with punch forceps and subsequent diathermic coagulation of the base. The patency of the bronchus was reestablished, and five months later the patient was symptom free and the lower lobe had reexpanded.

*Carcinoma.*—According to Faquino,<sup>31</sup> bronchiogenic carcinoma occurs more often in the right lung than in the left, and involvement of the lower lobes is more frequent than that of the upper. The insidious onset of this disease often interferes with an early diagnosis, which is essential to effective therapy. The more general use of bronchoscopic procedure in treatment of malignant growths in the lungs has facilitated not only prompt recognition of the condition but also selection of patients for operation by accurate localization of the lesion. Roentgenographic examination plays a large part in suggesting the presence of an early bronchial malignant growth, while the more advanced conditions present definite roentgen appearances. General belief is prevalent that bronchial carcinoma originates in the larger bronchi, but increased diagnostic facilities have demonstrated early lesions in bronchial subdivisions of the second or the third order so that infiltration of the stem bronchus may occur in the final stages. Treatment should be directed

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29. McGlade, T. H.: Fibro-Lipoma of the Bronchus: Report of a Case, *Ann. Otol., Rhin. & Laryng.* 48:240 (March) 1939.

30. Kramer, R.: Myoblastoma of the Bronchus, *Ann. Otol., Rhin. & Laryng.* 48:1083 (Dec.) 1939.

31. Faquino, G. J.: The Value of Bronchoscopy in Bronchiogenic Carcinoma, *New Orleans M. & S. J.* 91:429 (Feb.) 1939.

toward surgical extirpation when possible, the alternative being irradiation either by radon implantation or roentgen therapy. Faquino discussed 4 cases selected at random to typify the delayed diagnosis when only palliative therapy can be instituted.

Sixteen cases of malignant lesions and 3 of benign bronchial neoplasms were reported by Davis.<sup>32</sup> In 82 per cent of the cases the diagnosis was made by bronchoscopic examination in connection with biopsy, while in the remainder the bronchoscopic findings were sufficient to support the clinical diagnosis. When the actual tumor cannot be seen the bronchoscopic findings of fixation, rigidity, carinal widening and absence of respiratory movements form valuable evidence. Symptomatic analysis and diagnostic study are emphasized. In the 3 cases of benign growths the tumor was removed perorally, and Davis advocated that this method of treatment be used unless the tumor cannot be entirely eradicated. Lobectomy or pneumonectomy is recommended for treatment of malignant new growths in the bronchus.

Although Lockwood<sup>33</sup> stated that pain ranks third in frequency among symptoms of bronchial carcinoma his 3 patients all complained of pain. Wheeze as a symptom of pulmonary cancer is frequently overlooked but when accompanied by cough and bloody sputum constitutes strong evidence of neoplasm. Bronchoscopic examination still remains the most definite and positive diagnostic procedure available, although roentgenographic study renders valuable aid.

*Sarcoma.*—A case of primary sarcoma of the bronchus occurring in a youth aged 19 years was reported by Pollak and others.<sup>34</sup> The diagnosis was based on the bronchoscopic appearance of a soft spongy growth in the left main bronchus and on histologic studies of the tissue removed at several bronchoscopic examinations. Most of the tumor was extirpated bronchoscopically; the residuum was treated by fulguration. The patient was observed one year later and found to be free from recurrence of the tumor.

*Bronchopulmonary Tuberculosis.*—Advocating routine bronchoscopic examinations in all cases of active pulmonary tuberculosis, McIndoe and others<sup>35</sup> reported on their examination of 272 patients with tuberculosis observed over a period of more than one and a half years.

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32. Davis, E. W.: *Bronchial Tumors: Diagnosis and Treatment*, South. Surgeon **8**:47 (Feb.) 1939.

33. Lockwood, I. H.: *Primary Carcinoma of the Bronchus*, South. M. J. **32**: 30 (Jan.) 1939.

34. Pollak, B. S.; Cohen, S.; Barrone, M. G., and Gnassi, A. M.: *Primary Sarcoma of the Bronchus*, Am. J. Roentgenol. **41**:909 (June) 1939.

35. McIndoe, R. B.; Steele, J. D.; Samson, P. C.; Anderson, R. S., and Leslie, G. L.: *Routine Bronchoscopy in Patients with Active Pulmonary Tuberculosis*, Am. Rev. Tuberc. **39**:617 (May) 1939.

Eleven per cent of the patients showed evidence of tuberculous involvement of the trachea or bronchi, evidence based on the appearance of the lesion rather than on results of histologic examination. Persistent oral wheeze was the most frequent symptom encountered. Bronchial obstruction, unexplained spread of the tuberculous infiltration or atelectasis was most commonly associated with tuberculous tracheobronchitis. An analysis was made to determine whether bronchoscopic procedure exerted a deleterious effect on any of their patients. There was an increase in the pulmonary disease in only 4 patients, according to a comparison of the prebronchoscopic and postbronchoscopic roentgenograms. The laryngeal findings revealed no evidence of lasting severe tuberculous increase, either traumatic or nonspecific. In some cases the quantity of sputum was increased for a few days after bronchoscopic procedure, but there was no significant change on the basis of the number of tubercle bacilli found. There were rises in temperature among a small group of patients, but these were not regarded as significant.

Morlock and Hudson<sup>36</sup> cited their patients as illustrative of indications for the use of the bronchoscope in dealing with pulmonary tuberculosis. The patients consisted of those with normal sputum, those showing areas of collapse or obstructive emphysema, those with symptoms suggestive of tracheobronchial tuberculosis and those in whom there was another associated disease. Whether the indications for bronchoscopic procedure are restricted to the ones noted or whether these are to be extended, Morlock and Hudson express the opinion that this diagnostic procedure can yield valuable information in a number of cases of pulmonary tuberculosis, that it is harmless and that it will be used more extensively.

According to a report submitted by Holbrook and Rabinowitz,<sup>37</sup> 414 bronchoscopic examinations were performed on 284 patients. Of these patients, 66 were nontuberculous and 218 tuberculous. In a majority of the tuberculous patients the disease was far advanced. On 66 the bronchoscopic examination was performed before thoracoplastic operation; other indications, besides the bronchoscopic findings, were persistently positive sputum after collapse therapy (determining the side on which the active disease was located), wheezing respiration, suspected atelectasis, persistently normal sputum with positive roentgen findings and positive sputum with little roentgen evidence. In the experience of Holbrook and Rabinowitz the treatment of tuberculous bronchitis has been unsatisfactory.

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36. Morlock, H. V., and Hudson, E. H.: *Bronchoscopy in Pulmonary Tuberculosis*, *Brit. M. J.* **1**:381 (Feb. 25) 1939.

37. Holbrook, J. H., and Rabinowitz, P.: *Bronchoscopy in the Sanatorium*, *Canad. M. A. J.* **41**:542 (Dec.) 1939.

Three cases in which there were normal roentgen findings and no acid-fast bacilli in the sputum and in which the diagnosis of active pulmonary tuberculosis was made at bronchoscopic examination were reported by Shipman.<sup>38</sup> In all the cases, smears and cultures made from bronchial secretions showed acid-fast bacilli, and in 1 case cicatricial stenosis of the right bronchus was found.

In the opinion of Cohen and Wessler,<sup>39</sup> tuberculous infection of the trachea and bronchi is always secondary to some previously existing focus of tuberculosis in the chest and is usually found in patients with rather far advanced pulmonary disease for whom the prognosis is poor. A review of 20 cases revealed that the lesion occurred most commonly in a main bronchus and resulted in atelectasis either of a lobe or of an entire lung. Whenever in the course of pneumothorax treatment a collapsed lobe exhibits no tendency to reexpand when the treatment is discontinued, one may suspect an obstruction of the bronchus. A wheeze or rhonchus is additional evidence in support of this suspicion. Since the bronchi in the presence of long-standing pulmonary tuberculosis may be insensitive to inflammatory changes of the mucous membrane, bronchial lesions may be latent for a considerable time and may be overlooked unless routine bronchoscopic examinations are carried out. In young children the rupture of caseous lymph nodes into a bronchus has been recognized, while in adults such nodes may compress and erode neighboring structures with serious consequences to the bronchi, the pulmonary blood vessels and the lungs. As the patient grows older the caseous nodes tend to become anthracotic and indurated, so that the tendency toward ulceration and obstruction is not so great. Adhesion of necrotic lymph nodes to the esophagus may produce small traction diverticula. Severe and fatal pulmonary hemorrhage may follow erosion of a branch of the pulmonary artery and of the bronchial wall, while ulcerations and tuberculous granulations do not seem to give rise to severe hemoptysis. Simple tuberculous ulcerations of the mucous membrane either heal spontaneously or respond to chemical cauterization. Cohen and Wessler contended that endobronchial dilation of strictures is inadvisable and that physiologic rest of the lung produced by complete closure of the strictured bronchus is necessary for cure.

With the more common employment of the bronchoscope in dealing with tuberculosis, the recognition of tuberculous tracheobronchitis and the use of direct treatment have received considerable attention. In a

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38. Shipman, S. J.: Diagnostic Bronchoscopy in Occult Tuberculosis, *Am. Rev. Tuberc.* **39**:629 (May) 1939.

39. Cohen, A. G., and Wessler, H.: Clinical Recognition of Tuberculosis of the Major Bronchi, *Arch. Int. Med.* **63**:1132 (June) 1939.



bronchoscopic study of 516 tuberculous patients, Hawkins<sup>40</sup> found 132 who showed gross evidence of tuberculous bronchitis. In a majority the involvement was unilateral. In 43 of these there was extensive ulceration of the major bronchus, with extension into the trachea in 27 patients. In a few the main bronchus was completely occluded. Although bronchoscopic examination in connection with tuberculosis has not been routinely done by Hawkins, this examination was carried out on patients who exhibited the classic symptoms and signs of tuberculous tracheobronchitis, namely asthmatoïd attacks, wheeze, rhonchi, dyspnea out of proportion to vital capacity, excessive cough with tenacious sputum, constant tendency to clearing of the throat and persistently positive sputum with no other evidence of pulmonary tuberculosis. In Hawkins' case a majority of tuberculous mucosal ulcerations in the tracheobronchial tree healed more readily and with less stenosis when treated with cauterization than when untreated. Complications due to the use of the bronchoscope in cases of tuberculosis are rare.

Omerod<sup>41</sup> stated that tuberculosis of the tracheobronchial tree is most common in patients between the ages of 20 and 40 years and in the majority of cases is associated with advanced pulmonary infection. He contended that if the larynx is involved and there is tuberculous disease of the trachea the condition will be found in the upper part of that tube, with perhaps some lesions in the lower part of the trachea and bronchi. In those cases in which the larynx is normal, the disease is usually confined to the lower half of the trachea and bronchi. From a study of available statistics Omerod concluded that tuberculous lesions occur in about 10 per cent of all cases of pulmonary phthisis, but that in the more severe types of the disease, such as those requiring thoracoplastic procedure, the incidence is much higher.

The report of Nalls and Cole<sup>42</sup> showed them to be agreed with other writers that the final diagnosis of the presence and the cause of bronchial obstruction in pulmonary tuberculosis rests on visualization of the lesions by bronchoscopic examination. The bronchoscopic findings of bronchial ulceration observed in their cases are graphically shown.

The importance of bronchoscopic examination of tuberculous patients before thoracoplastic operation is emphasized by Benedict,<sup>43</sup> who

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40. Hawkins, J. L. H., Jr.: Tuberculous Tracheobronchitis, *Am. Rev. Tuberc.* **39**:46 (Jan.) 1939.

41. Omerod, F. C.: Tuberculous Tracheobronchitis, *Brit. J. Tuberc.* **39**:29 (Jan.) 1939.

42. Nalls, W. L., and Cole, D. B.: Tuberculous Tracheobronchitis, *Virginia M. Monthly* **66**:387 (July) 1939.

43. Benedict, E. B.: Bronchoscopic Dilatation of Bronchial Stenosis Following Thoracoplasty for Tuberculosis, *New England J. Med.* **220**:617 (April 13) 1939.

reported 3 cases in which postoperative bronchial stenosis developed after thoracoplastic procedure. He expressed the belief that the stenosis was caused by preexisting tuberculous tracheobronchitis and that the subsequent collapse of the lung resulted in an approximation of mucous surfaces, local spread of the disease, ulceration and stenosis. Gradual dilation of the stenosed parts and aspiration of retained secretions were carried out with marked benefit to the patients. Although the bronchial lumen remained patent after dilation, Benedict advocated repetition of this procedure to prevent recurrent stenosis. No activation of the tuberculous process after bronchoscopic manipulation was noted.

*Aspergillosis.*—Invasion of the lung by aspergilli may be more common than would appear from the number of reported cases. The clinical course of bronchopulmonary aspergillosis is similar in many respects to that of chronic pulmonary tuberculosis and in some cases is considered as such. The patient reported by Stolow<sup>44</sup> was referred as having pulmonary tuberculosis. Results of examination for tubercle bacilli were repeatedly normal. The patient, a farmer, acquired a cough while threshing oats. This later became productive, and hemoptysis occurred. Because of the history, the presence of signs over the upper lobe of the right lung and the absence of tubercle bacilli, bronchoscopic examination was performed. This revealed inflamed and thickened mucosa in the right bronchus, with a small quantity of thick mucopus. Bacteriologic study of secretions revealed a member of the genus *Aspergillus*. Stolow emphasized the importance of a careful history and studies of the sputum for fungus in cases of patients thought to be tuberculous but with normal sputum.

*Lung Mapping.*—The disappearance of the roentgenographic shadows of pulmonary abscess with its surrounding pneumonitis and the absence of symptoms referable to the suppurative process usually are accepted as conclusive evidence that an abscess has healed. Franklin<sup>45</sup> studied a group of cases of apparently healed pulmonary abscess and found that residual pathologic defects in the lung and bronchi often may be demonstrated by instillation of iodized oil. He expressed the opinion that this procedure should be employed routinely in these cases to ascertain the condition of the bronchial tree and that the clinical concept of healing of acute suppurative bronchopulmonary processes should take into account the residual pathologic changes in the lungs and bronchi.

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44. Stolow, A. J.: Primary Broncho-Pulmonary Aspergillosis, J. M. Soc. New Jersey **36**:484 (Aug.) 1939.

45. Franklin, R. M.: Bronchographic Study of Apparently Healed Lung Abscess, Am. J. M. Sc. **198**:95 (July) 1939.

Soulas<sup>46</sup> discussed the general indications for the instillation of iodized oil as a diagnostic procedure. The purpose for which it is most frequently employed is for ascertaining the presence of bronchial dilations. Next in frequency is the determining of the presence of bronchial stenosis of either intrinsic or extrinsic origin. Various methods of introduction, including transglottic injection, transnasal instillation by cannula or catheter and the bronchoscopic method, were discussed. The bronchoscopic method is valuable for children; it is also advantageous in cases of bronchial stenosis, as it permits introduction of the oil under direct visual guidance.

Pearson and Thornton<sup>47</sup> described a bronchoscopic method for children, in which a small Magill tube is inserted through the nose into the trachea, with the child under general anesthesia. A catheter is passed through the endotracheal tube, and iodized oil is instilled into the bronchi under fluoroscopic guidance.

For mapping pulmonary fields and securing bronchial secretions Rudman<sup>48</sup> used a semirigid catheter placed in the tracheobronchial tree by mirror laryngoscopic procedure. Local anesthesia is applied to the larynx and trachea, the catheter is inserted and iodized oil is instilled under fluoroscopic guidance. By placing the tip in the desired locality and using curved catheters, one may fill the upper and the middle lobe, obviating the need of utilizing posture.

*Lipoid Pneumonia.*—A series of 27 cases of lipoid pneumonia in children was studied by Bromer and Wolman.<sup>49</sup> Among 20 cases in which autopsy was performed, recognition of the condition before death occurred in only 1 case, even though roentgen examinations were performed in the great majority. In two thirds of the cases the pneumonia was associated with some debilitating disease. The site of involvement was always the posterior dependent portions of the lungs, especially the perihilar regions, and the right lung was affected more often than the left. Identification of the oils was not definite, but cod liver oil seemed to be the chief offender; a few of the infants had received petrolatum nose drops. Serial roentgenograms were stressed as valuable aids in diagnosis.

*Obstructive Asphyxia.*—In an endeavor to explain the cause of death occurring immediately after a successful tracheotomy for obstructive

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46. Soulas, A.: Endobronchial Instillation of Iodized Oil in Adults and in Children, *Bronchoscop., œsophagoscop. et gastroscop.*, April 1939, p. 125.

47. Pearson, H. E. S., and Thornton, H.: *Bronchography in Children*, *Brit. J. Radiol.* **12**:229 (April) 1939.

48. Rudman, I. E.: *Bronchial Catheterization*, *Am. Rev. Tuberc.* **39**:329 (March) 1939.

49. Bromer, R. S., and Wolman, I. J.: *Lipoid Pneumonia in Infants and Children*, *Radiology* **32**:1 (Jan.) 1939.

asphyxia, Gatewood and Cary<sup>50</sup> carried out a series of experiments on previously tracheotomized dogs. In one group the airway was obstructed for twenty-four hours, and studies of the blood were then carried out. When this procedure was completed, the obstruction was suddenly released and opportunity given for the animal to breathe through a large unobstructed airway. A second series of studies of the blood were then performed. In a small group of animals the obstruction was continued for only fifteen hours.

Gatewood and Cary concluded that the apnea caused by mechanical asphyxia in animals duplicated the human picture of obstructive anoxia. The sudden lowering of arterial carbon dioxide tension in the animal did not apparently induce any serious or fatal effects on the respiratory center. In the presence of acutely precipitated alkalemia and a sudden drop in carbon dioxide tension, respiration may be disturbed. However, these experiments on animals did not indicate that death can be induced by this phenomenon alone.

#### ESOPHAGOSCOPY

*Tracheoesophageal Fistula.*—Congenital tracheoesophageal fistula is of uncommon occurrence. Imperatori<sup>51</sup> reported a case of fistula in a boy aged 7 years; he closed the fistula successfully by plastic operation. The tracheoesophageal opening, about  $\frac{1}{2}$  inch (1.27 cm.) long, appeared as a slit in the party wall slightly to the left of the sagittal plane opposite the ends of the third, the fourth and the fifth tracheal ring. At the beginning of the swallowing act it remained closed, but as the larynx receded the opening of the fistula was seen from the tracheal side. There were spastic reactions of the pylorus and cardia, and earlier treatment had been directed toward correcting these. Because of the repeated occurrence of respiratory symptoms, additional studies were carried out, and the fistula was discovered by tracheoscopic examination. Since closure of the fistula the patient has been able to eat without difficulty, although some cardiospasm is still probably present.

A bronchoesophageal fistula occurring in a man aged 31 who had serious compression of the thorax as a result of accident was reported by Piquet and others.<sup>52</sup> The opening in the airway was in the right main bronchus slightly beyond the carina. At this point the right bronchus was distended. The esophagus was greatly dilated at the level

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50. Gatewood, E. T., and Cary, M. K.: Certain Phases of Respiratory Failure: An Experimental Study of Subacute Obstructive Asphyxia, *Ann. Otol., Rhin. & Laryng.* **48**:1073 (Dec.) 1939.

51. Imperatori, C. J.: Congenital Tracheoesophageal Fistula Without Atresia of Esophagus, *Arch. Otolaryng.* **30**:352 (Sept.) 1939.

52. Piquet, J.; Muller, M., and Marchand, M.: Broncho-Esophageal Fistula Following Thoracic Trauma, *Bronchoscop., œsophagoscop. et gastroscop.*, January 1939, p. 27.

of the fistula, and there was distortion of the trachea, the right main bronchus and the esophagus, together with fixation, suggesting that a hard fibrous mass united the esophagus and the tracheobronchial tree.

*Foreign Bodies.*—Reporting on a series of 200 cases in which the esophagoscope was used to detect the presence of foreign body, Wrigley<sup>53</sup> emphasized the importance of diagnostic esophagoscopy procedure in all cases in which the roentgenologist is unable to give an absolutely negative report. In a number of cases in which there was a history of the swallowing of some object, the roentgenographic report indicated the presence of a residual flake of barium. In many of these cases the roentgenographic report was negative, but a foreign body was found in a sufficiently large number to justify routine esophagoscopy examination. In 180 of the 200 consecutive cases a foreign body was found and removed; in 6 the foreign body was seen but passed into the stomach, and in 1 case the foreign body was seen but was immovable. In 13 cases the examination revealed no foreign body. Death occurred in 2 cases in the series. In one of these, in which an impacted denture could not be removed owing to a sharp hook which had perforated the esophagus, death resulted from mediastinitis following attempted esophagotomy. In the other case, death followed perforation of the esophagus by a fragment of bone.

*Stricture of the Esophagus.*—In an analysis of 50 cases of esophageal stricture, Martin and Arena<sup>54</sup> found 48 in which the condition was due to ingestion of lye. In over half of these the patients were children under 2 years of age. The most common anatomic site was the upper third of the esophagus; in 10 cases the strictures were multiple. Following the initial symptoms there is usually a period of one to two weeks with no apparent dysphagia; symptoms return after the formation of stricture, with stenosis of the lumen. Provided the initial poison has been neutralized, Martin and Arena advocated the passage of a mercury-filled catheter into the stomach, as outlined by Bokay, treatment to be begun four days after the accident if the edema and inflammation have subsided sufficiently. Peroral bougienage with a string used as a guide, retrograde bougienage through a gastrostomy opening, peroral esophagoscopy bougienage or retrograde esophagoscopy bougienage must be employed in treating the already developed stricture. In this series there were 8 deaths, 1 of which was attributable to a cause other than the esophageal lesion.

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53. Wrigley, F. G.: A Series of Two Hundred Cases of Oesophagoscopy for Foreign Bodies, *Brit. M. J.* **2**:334 (Aug. 12) 1939.

54. Martin, J. M., and Arena, J. M.: Lye Poisoning and Stricture of the Esophagus, *South. M. J.* **32**:286 (March) 1939.

Restoration of function in cases of nonmalignant esophageal stenosis can be accomplished by the accepted methods of dilation in the great majority of cases, but Turner<sup>55</sup> expressed the belief that there are a few conditions requiring some form of reconstructive surgical procedure, such as esophagoplasty. According to Turner, the incidence of esophageal stricture in England is much less than in other countries. Case reports illustrated the results obtained by the standard methods of treatment, and several deaths occurred after instrumentation. He stated the opinion that patients can be taught to swallow bougies with safety; no force is used, and when possible supervision of the dilation is carried out. Gastrostomy has definite value in treatment, not only for maintaining nutrition but also for carrying out retrograde bougienage. In the 19 cases referred to, the causative factors, so far as could be determined, were as follows: corrosives in 5; congenital defects, 5; late results of achalasia, 4; ulceration, 2; acute inflammation, 1, and undetermined in 2.

Benign stricture of the esophagus is observed less frequently than cardiospasm or esophageal carcinoma. According to the experience of Vinson,<sup>56</sup> no etiologic factor can be ascertained in about 20 per cent of cases of stricture of the esophagus. In these, carcinoma commonly is suspected. Diagnosis may be difficult even when esophagoscopy examination is employed. Stricture at the esophagogastric junction is often observed in patients with congenital shortening of the esophagus. Gastrostomy is seldom necessary in the management of benign stricture of the esophagus. With a thread employed as a guide for passing sounds, a benign stricture can be dilated with minimal risk and discomfort and with an excellent functional result. Complete anatomic stenosis of the esophagus can always be prevented by having the patient swallow a thread and allowing it to remain until the dilation has been completed.

The present methods of dilating cicatricial stenosis of the esophagus were described by Eeman,<sup>57</sup> who pointed out certain features which could be improved. He expressed the belief that instead of applying the distending force in an up and down direction one should apply it in the plane in which dilation of the tissues is desired. The conic form of the dilating instruments does not compensate for the mechanical error of the application of force. The forceful application of the dilating

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55. Turner, G. G.: Nonmalignant Stenosis of the Esophagus, *Brit. J. Surg.* **26**:555 (Jan.) 1939.

56. Vinson, P. P.: Management of Benign Stricture of the Esophagus, *J. A. M. A.* **113**:2128 (Dec. 9) 1939.

57. Eeman, F. G.: The Brady-Diastase Treatment of Esophageal Stenosis, *Bronchoscop., œsophagoscop. et gastroscop.*, January 1939, p. 40.

apparatus does not permit any gliding of the tissue fibers over one another and therefore does not utilize, except partially, the elasticity of the fibrous tissue. Instead it provokes sudden tearing of these fibers, which is followed by further formation of scar tissue. Eeman proposed to replace this method by one he called Brady-diastrase, which is based on the principle that a minimal force applied for a prolonged period is more efficacious than a rapidly dilating force applied for a short time. These objectives are accomplished by using as dilating agents the hydrostatic dilating balloons (Stark) and by applying the force over a longer period.

*Ulcer of the Esophagus.*—The concomitance of duodenal and of esophageal ulcer, although uncommon, is of interest. The patient examined by Klein and Hochbaum<sup>58</sup> was operated on for duodenal ulcer. Two months later he was readmitted because of dysphagia. Esophagosopic examination revealed an extensive ulcerated lesion involving the lower part of the esophagus. The appearances suggested carcinoma. When the patient was observed one year later, cicatricial stenosis of the esophagus was found. This responded promptly to dilation, and return of normal esophageal function was obtained.

The symptoms of ulcer of the esophagus often suggest a clinical diagnosis of gastric ulcer. The failure to find any evidence of ulcer by the routine roentgen examination often leads to a revision of the diagnosis. Briggs, Dick and Hurst<sup>59</sup> have found that esophageal ulcer is almost always associated with herniation of the stomach through the diaphragm and with congenitally short esophagus. A small hernia is often overlooked in a routine roentgen study. Both the ulcer and the hernia can be demonstrated by examining the patient in the horizontal position. The diagnosis can always be confirmed by esophagosopic examination.

Two conditions of which one is necessary for the production of peptic ulcer of the esophagus are (1) gastric mucosa in the lower portion of the esophagus and (2) a relaxed cardia through which gastric juice is constantly regurgitated. Chamberlin<sup>60</sup> suggested that the patency of the cardia might be caused by congenitally short esophagus or diaphragmatic hernia. In his 7 cases either one or both of these abnormalities were present. He named the diagnostic criteria of peptic

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58. Klein, I., and Hochbaum, W.: Stenosing Esophagitis Associated with Duodenal Ulcer, *Am. J. Roentgenol.* **42**:724 (Nov.) 1939.

59. Briggs, P. J.; Dick, R. C. S., and Hurst, A.: Simple Ulcer of the Oesophagus and Short Oesophagus, *Proc. Roy. Soc. Med.* **32**:1423 (Sept.) 1939.

60. Chamberlin, D. T.: Peptic Ulcer of the Esophagus, *Am. J. Digest. Dis.* **5**:725 (Jan.) 1939.

ulcer of the esophagus as follows: (1) The ulcer is chronic and unassociated with systemic disease; (2) the symptoms are relieved by peptic ulcer therapy and dilation; (3) free hydrochloric acid is present in the stomach, and (4) the ulcer is visualized by direct examination.

*Periesophageal Abscess.*—In discussing periesophageal abscesses, Hunt<sup>61</sup> stated that rupture of the esophagus is due to foreign bodies, instrumentation or spontaneous rupture accompanying malignant growth. The most frequent site of perforation is at the upper end, at the cricopharyngeus muscle, for it is there that foreign bodies and instruments first meet resistance. In an analysis of 20 cases of periesophageal abscess Hunt found that in 17 the perforation of the esophagus was caused by foreign body, that in 1 the rupture followed instrumentation and in 2, biopsy. A diagnosis of cervical periesophageal infection is made on the basis of a suspected or observed perforation of the esophagus, marked collapse of the patient at the time of the perforation, pain, tenderness and swelling over the area of dysphagia, sudden rise in temperature with increased leukocyte count, the roentgen signs of widening of the prevertebral or post-tracheal space and emphysema, which may be ascertained by palpation or by roentgen examination. A roentgen study is the determining factor in diagnosis and aids in differentiating between simple cellulitis and abscess formation. In 16 of the 20 cases operation was done and external drainage established, with 12 recoveries and 4 deaths. In the remaining 4 cases, in all of which death occurred, operation was not performed but conservative or esophagosopic treatment was given.

*Cardiospasm.*—Bougienage of one variety or another has been practiced for more than fifty years in the treatment of cardiospasm. Browne and McHardy<sup>62</sup> discussed the various methods of dilation and described a mercury pneumatic dilator which they have found useful. Its advantages are as follows: 1. A previously swallowed guiding thread is not required and the instrument is readily passed, being the size of a number 21 Hurst dilator. It is carried through by virtue of the contained mercury, which is sufficient to force the closed sphincter and is in itself a guide. 2. The dilator is passed with less discomfort and does not exhibit a tendency to coil in the dilated prediaphragmatic dilatation. 3. Only a single instrumentation is required, and the dilator offers controlled pneumatic divulsion.

61. Hunt, W. M.: Periesophageal Abscesses: The Importance of Early Surgical Interference, *Ann. Otol., Rhin. & Laryng.* **49**:128 (March) 1939.

62. Browne, D. C., and McHardy, G.: A New Instrument for Use in Esophagospasm, *J. A. M. A.* **113**:1963 (Nov. 25) 1939.



In Tucker's<sup>63</sup> experience gentle dilation or stretching of the hiatal esophagus repeated over a considerable period has given the most favorable results in the treatment of cardiospasm. Preliminary roentgen study and open tube esophagoscopy examination of the lower end of the esophagus and cardia should be done, he said, in every case. The mercury-filled pneumatic dilator was described in his paper, and cases were cited in which this method of treatment was successfully employed.

In discussing the reflex etiologic factor in cardiospasm, Bryant<sup>64</sup> did not assume that in all cases the condition could be attributed to reflex etiologic causes. Cases were cited to support the belief, however, that anything which unduly disturbs the reflex arc of the myenteric plexus may serve as an exciting cause of functional stenosis of the esophagus. These cases suggest further that in the event of an obstinate condition which is not relieved by the commonly employed methods of treatment a painstaking search for lesions elsewhere should be resorted to, and furthermore that even when the condition is relieved by ordinary measures reflex factors should be sought so that, if they should be found, their correction could help in the prevention of relapses.

#### TUMORS OF THE ESOPHAGUS

*Osteochondroma.*—In reporting a case of osteochondroma of the esophagus, Reeves<sup>65</sup> directed attention to the rarity of this type of tumor in the esophagus. The pedunculated tumor in the reported case was located in the upper thoracic portion of the esophagus and was removed with a cutting forceps after exposure with a Jackson esophageal speculum. The symptoms disappeared for six months after removal; the patient gained 30 pounds (13.6 Kg.) and was able to return to work.

*Adenocarcinoma.*—Polyps of the esophagus probably constitute the most common type of benign tumor, but the carcinomatous polyp is an unusual finding. Feldman<sup>66</sup> observed a case of adenomatous pedunculated polyp occurring in the upper part of the esophagus. The roentgen appearances exhibited a large polyp which was clearly outlined and appeared to be movable especially when the patient changed position. In the esophagoscopy procedure the polyp was sucked up into the end of the tube. A biopsy was done. The histologic diagnosis was adenocarcinoma. This type of tumor is extremely rare in the upper part of the esophagus.

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63. Tucker, G.: Cardiospasm: A Pneumatic-Mercury Dilator, *Ann. Otol., Rhin. & Laryng.* 48:808 (Sept.) 1939.

64. Bryant, D. L.: A Consideration of the Reflex Etiology of Cardiospasm, *Ann. Otol., Rhin. & Laryng.* 48:802 (Sept.) 1939.

65. Reeves, E.: Osteochondroma of the Esophagus Removed Perorally with the Aid of a Speculum, *Arch. Otolaryng.* 29:151 (Jan.) 1939.

66. Feldman, M.: Adenocarcinomatous Pedunculated Polyp of the Esophagus: Report of a Case, *Am. J. Digest. Dis.* 6:453 (Sept.) 1939.

## GASTROSCOPY

*Gastritis.*—The diagnosis of gastritis is difficult to make, and McNeer and Barowsky<sup>67</sup> reported a series of 143 cases in which gastroscopic observations were necessary before definite conclusions could be reached. Their most striking finding was the presence of some form of gastritis in over half the patients studied. Many of the patients (37.8 per cent) with conditions previously diagnosed as “functional dyspepsia” were found to have chronic gastritis. McNeer and Barowsky experienced difficulty in classifying the types of gastritis. Three fourths of the patients with true achylia had an atrophic type, while almost all had some chronic changes. The incidence of chronic inflammation was highest in association with achylia, followed in order of frequency by the gastritides associated with carcinoma, those occurring with chronic resistant duodenal ulcer, those following gastroenterostomies and those in the undiagnosed group. Clinical, laboratory and roentgen study does not give much information in a majority of cases; in occasional cases of advanced hypertrophic gastritis, however, the roentgenograms may lead to accurate diagnosis. Pathologic studies of gastritis are greatly handicapped because of the rapid autolysis of gastric tissue which takes place at postmortem examination.

In an attempt to correlate the clinical and gastroscopic findings, Bank and Renshaw<sup>68</sup> studied 50 cases of chronic superficial gastritis, diagnosed by means of the gastroscope. Some variation in the normal gastric acidity was noted in 80 per cent of this series, hyperacidity being present in 50 per cent. A tendency toward delayed emptying of the stomach, loss of weight and symptoms suggestive of duodenal ulcer were prominent features. Bank and Renshaw were not able to arrive at any characteristic syndrome of chronic superficial gastritis.

Gastroscopic examination afforded a supplementary diagnostic method of study in 200 cases of lesions of the stomach in which examination was made by Freeman.<sup>69</sup> He expressed the opinion that the greatest field for usefulness of the gastroscope is in the diagnosis of the different types of chronic gastritis, although valuable information can be obtained on conditions following gastric operations, obscure gastric hemorrhages, carcinoma and ulcer.

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67. McNeer, G., and Barowsky, H.: A Gastroscopic Study of the Incidence of Chronic Gastritis in Common Gastric Afflictions, *Am. J. Digest. Dis.* **6**:180 (May) 1939.

68. Bank, J., and Renshaw, J. F.: Chronic Superficial Gastritis, *J. A. M. A.* **112**:214 (Jan. 21) 1939.

69. Freeman, E. B.: Gastroscopic Study Compared with Other Methods of Diagnosis in Gastric Lesions, *J. A. M. A.* **122**:217 (Jan. 21) 1939.

In discussing the importance of gastroscopic examination in cases of cancer of the stomach, Liebowitz<sup>70</sup> presented several cases in which that method proved of considerable aid in determining the presence or absence of gastric cancer and in differentiating benign and malignant ulcerations of the stomach. The interpretation of the roentgen shadows can be greatly aided by a knowledge of the gastroscopic appearances of a lesion. The use of the gastroscope is particularly of value in attempts to recognize gastritis which often simulates neoplasm both clinically and radiologically. The employment of gastroscopic examination to supplement roentgen studies and clinical and laboratory examinations will aid in making the diagnosis and detection of gastric cancer more accurate than heretofore.

In a study representing 317 gastroscopic observations on 91 patients, each of whom presented a definite, benign gastric ulcer, Schindler and Baxmeier<sup>71</sup> found two types of mucosal alteration. Inflammatory changes ranging from the reddening, edema and exudation in the superficial form to the segmentation, node formation and erosive changes in the hypertrophic type were observed in 38 patients at the first examination and at some subsequent examination in an additional 10 patients in whom gastritis was not present when they were first examined. In 43 patients with ulcer no gastritis was discovered. Purpuric type changes, which include mucosal hemorrhages, pigment spots and hemorrhagic erosions, were observed in 40 patients. In the series of 43 patients who presented no evidence of gastritis many were examined on more than one occasion, a fact which suggests that the absence of inflammation was not due to a regressive phase. Of the 38 patients with gastritis and ulcer, 16 presented evidences of inflammation which was entirely remote from the ulcer; in 10 the ulcer was found lying in a circumscribed zone of inflammation of variable size, and in 12 there was diffuse gastritis involving extensive areas of the fundus or of both the fundus and the antrum. The incidence of purpuric type lesions in patients not suffering from gastric ulcer is not greater than 6 per cent. It is of interest to note that among 91 patients with ulcer these lesions were observed in 40 (44 per cent).

*Carcinoma.*—Although the value of gastroscopic examination for early diagnosis of gastric carcinoma is disputed, gastroscopists recognize its value in the differential diagnosis of benign and malignant lesions and in the determination of operability. Schindler and Gold<sup>72</sup> expressed

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70. Liebowitz, H. R.: Gastroscopic Observations in Gastric Cancer, *Rev. Gastroenterol.* **6**:516 (Nov.-Dec.) 1939.

71. Schindler, R., and Baxmeier, R. I.: Mucosal Changes Accompanying Gastric Ulcer: A Gastroscopic Study, *Ann. Int. Med.* **13**:693 (Oct.) 1939.

72. Schindler, R., and Gold, R. L.: Gastrosocopy in Gastric Carcinoma, Especially in Its Early Diagnosis, *Surg., Gynec. & Obst.* **69**:1 (July) 1939.

the opinion that examination by means of the gastroscope does facilitate early diagnosis and that at times it is superior to all other methods. Ten cases were presented by them to demonstrate the importance of gastroscopic examination in relation to the diagnosis of cancer. In 2 cases an early diagnosis was made only by gastroscopic examination; in 2 additional cases the diagnosis was made conclusive by gastroscopic means; in 3 examination by the gastroscope was important in the differential diagnosis between benign and malignant ulceration, and in the remaining 2 it was valuable in the determination of operability. Gastroscopic and roentgen examination are not competitive, but each supplements the other. Close cooperation between the radiologist and gastroscopist, therefore, is essential in order to make a diagnosis early. An early diagnosis can be made in every case of cancer if roentgenologic and gastroscopic examinations are carried out promptly on the appearance of mild digestive symptoms and of loss of weight which is otherwise unexplained.

*Pernicious Anemia.*—Schindler and Serby<sup>73</sup> reported on the gastroscopic findings in 23 patients with pernicious anemia. Nine patients did not receive treatment and showed evidences of atrophic or superficial gastritis, either diffuse or patchy and distributed in both the antrum and the body. After receiving treatment, 4 of the 14 patients exhibited no appreciable improvement of the gastric mucosa, while in the remainder almost complete regeneration occurred. Polyps of the mucosa were observed rather frequently in this series.

*Phytobezoar.*—A case of phytobezoar (food ball) in the stomach, in which diagnosis was based on gastroscopic examination and confirmed at operation, was reported by Ruffin and Reeves.<sup>74</sup> They expressed the opinion that the development of this condition is frequently associated with the ingestion of persimmons; for thirty or forty years their patient had been in the habit of eating at least a quart of persimmons every fall.

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73. Schindler, R., and Serby, A. M.: Gastroscopic Observations in Pernicious Anemia, *Arch. Int. Med.* **63**:334 (Feb.) 1939.

74. Ruffin, J. M., and Reeves, R. J.: The Value of Gastroscopy in the Diagnosis of Phytobezoar, *Am. J. Digest. Dis.* **5**:745 (Jan.) 1939.

# Abstracts from Current Literature

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## Ear

THE CENTRAL CONNECTIONS OF THE VESTIBULAR PATHWAYS. W. E. DANDY and P. A. KUNKEL, *Am. J. M. Sc.* 198:149 (Aug.) 1939.

The authors sectioned one or both eighth nerves and removed one or both cerebellar hemispheres with and without section of the eighth nerves on a series of dogs and cats. Section of one eighth nerve always resulted in violent whirling of the animal toward the same side, continuing until the animal died of exhaustion a day or two later. Section of both eighth nerves resulted in whirling first to one side and then to the other. Removal of one or both cerebellar hemispheres resulted in loss of equilibrium, but there was never any whirling. Section of one eighth nerve combined with removal of half the cerebellum on the same side resulted in violent whirling, but if the opposite half of the cerebellum was removed instead there was no whirling. The authors conclude that the vestibular pathways decussate like the pyramidal tracts.

(Comment: This conclusion seems to the reviewer to be unwarranted for the following reason: The whirling that occurs after section of one eighth nerve is due to unopposed tonus impulses from the opposite labyrinth. The fact that removal of the cerebellar hemisphere on the side of the cut nerve does not stop the whirling whereas removal of the hemisphere on the side of the intact nerve does control the whirling means that the vestibular pathways go to the cerebellar hemisphere of the same side and do *not* decussate. This is in harmony with clinical experience and anatomic studies.)

SHAMBAUGH, Chicago.

WHAT CONCLUSIONS CAN BE REACHED THROUGH A VESTIBULAR EXAMINATION AS TO THE TYPE AND LOCATION OF AN INTRACRANIAL DISEASE? RUDOLF LEIDLER, *Pract. oto-rhino-laryng.* 2:86 (May); 152 (July) 1939.

In a long, comprehensive discussion, the author devotes the first half of his presentation to a description of the anatomic relation between the vestibular nerve and the central nervous system. He traces the nerve and its fibers from their labyrinthine origin to the termination in the spinal cord. He continues with a minute description of the intercommunication between the vestibular nuclei and the ramifications through the upper and lower centers and the interrelation with other tracts and nuclei.

The second half of his discussion deals with the clinical application of various symptoms, treating nystagmus as the most important finding and vertigo as the second. He states that, while nystagmus can be shown on a purely anatomic basis to result from a direct relation between the vestibular nuclei and the nuclei of the eye muscles, the association of vertigo is not clear. However, certain facts are established with a fair degree of certainty in the relation of the structure of the vestibular system to vertigo. The communication of the vestibular system with the motor cells of the anterior horn and the motor nuclei is weak and in man is difficult to establish as an influence on equilibrium. He believes that otolaryngologists in general have overestimated the effect of the labyrinth on equilibrium. He states that with acute unilateral destruction of the labyrinth disturbances of equilibrium are of only short duration and that persons with vertigo of peripheral labyrinthine origin during the quiescent stage do not show any disturbances of equilibrium. He feels also that the otolaryngologist can help the neurologist by careful analysis of the vestibular findings and so help determine

any central lesion and likewise that it is important that the neurologist call on the otolaryngologist for aid in any case of a suspected central lesion.

He then describes the method of examination, stressing the importance of the otoscopic observations on the ear drum, the responsivity of the cochlear system and the vestibular findings, noting particularly in the latter (1) spontaneous nystagmus, (2) caloric responses and (3) responses after rotation.

Some of his findings are as follows: First, disturbances in the vestibular system which are caused by disease of the brain.

I. Reflexes of the ocular muscles of vestibular origin (nystagmus and deviation).

A. Typical vestibular nystagmus composed of a slow and a quick component and normally not spontaneous. On stimulating a normal vestibular system with 5 cc. of water of 27 C. (Kobrak), typical nystagmus is produced to the side opposite the stimulation, and, after a latent period of about twenty seconds, the amplitude and the frequency of movement vary individually, but a pathologic state can be surmised only when there is marked disproportion in both amplitude and frequency on stimulation of the two sides. The last deduction is true also when the rotation test is made.

B. Atypical nystagmus following stimulation. This depends on a disturbance in rhythm.

1. Prolongation of the slow component.

2. Conjugate deviation of the eyes to the tested side plus typical nystagmus. After a caloric stimulation a normal latent period is followed by conjugate deviation in the direction of the slow component. In this position, typical nystagmoid movements follow; the quick component is usually smaller and weaker.

3. Typical nystagmus plus conjugate deviation to the stimulated side. This is the reverse of 2.

Disturbances of rhythm may appear in the following forms: 1. The various phases may follow each other in an irregular fashion. Between the phases, the eyes may rest quietly. 2. Frequently, there is a series of four or five phases of small amplitude, which may disappear quickly. There may be difficulty in differentiating between the slow and the quick components.

C. Conjugate lateral deviation of the eyes. In many cases of central disease of the vestibular system, deviation of the eyes can be seen behind the Frensel glasses and is apparent only when the glasses are used. The patient himself is unaware of this phenomenon. There may be also a uniphasic reaction, in which the quick component is lost. This really is maximal residual deviation of the eyes in the direction of the slow component.

D. Atypical, unrhythmic ocular movement, seen only behind the glasses in certain rare cases of a central vestibular lesion. This type should be differentiated from pendular nystagmus. While it does not have a vestibular origin, it is definitely influenced by the vestibular system.

E. Spontaneous pure rotary nystagmus. This is always seen in disease of the brain. However, frequently it is a rotary component of horizontal or vertical nystagmus.

F. Vertical reflex nystagmus. The association of this reaction with disease of the brain is difficult. However, while definite localization cannot be made, the assumption must be accepted that it is of central origin. Further experimental study of the phenomenon should be made.

- G. Postural nystagmus, which occurs when the patient in a horizontal posture looks either to the right or to the left and which disappears on a change in posture. Vertigo is commonly associated. This type of nystagmus is either purely horizontal or rotary, rarely mixed and more rarely vertical. It also usually occurs in only one posture and most frequently in the same direction. This form of nystagmus occurs only with central vestibular disturbances.

II. Disturbances of responses to caloric and rotatory stimulation. In diseases of the central nervous system, these disturbances are more common than previously assumed. One should not class the responses as hyperactive, hypoactive or nonactive. There may be various types of disturbance of these responses of the vestibular system.

- A. Extirpation of the cochlear nerve. The patient is deaf and does not respond to any vestibular stimulation.
- B. Nonsuppurative encephalitis. Here the cochlea is not involved and usually shows normal responses. The caloric test will show more or less disturbance, with a difference in the irritability of the two sides. For example, marked or normal nystagmus on one side may follow minimal stimulation, with a normal reaction from the opposite side only after a maximum stimulation.
- C. Disturbance of the vegetative nervous system. This is evidenced by normal or increased nystagmus, often associated with marked vertigo. The patient becomes either pale or flushed. The pulse rate and the breathing become affected. He shows extreme anxiety, pressure symptoms about the cardiac region, profuse sweating, general weakness, nausea, vomiting and fainting. These symptoms may last for some time, even several hours.
- D. Syringobulbia. This is evidenced by constant vertigo, with pure or almost pure rotary nystagmus of the second or third degree to the affected side, a normal cochlea and normal or only slightly increased irritability of the vestibular system.
- E. Disease of the central nervous system. Rare findings are associated with or accompany stimulation of the vestibular system, such as the maintaining of the head or the body in certain definite positions. The cause is unknown, and the site of the lesion is uncertain. There may be also disturbances of consciousness after stimulation of the vestibular system. These may be slight and transient or may occur with severe vertigo in diseases of the labyrinth. Epilepsy may fall in this class. Symptoms suggesting involvement of the cerebrum, such as headache, or of the extrapyramidal region, such as tremors of the head after stimulation, suggest central rather than peripheral lesions.

III. Vertigo. This is an important symptom of disease of the brain. However, the author does not believe that it is an evidence of intracranial pressure. It is usually an evidence of a vestibular influence, but it is difficult to differentiate between a labyrinthine and a central lesion.

The author then attempts to localize in the brain the lesions causing the various symptoms.

- I. Vertigo. He disputes the contention of the neurologist that since vertigo is merely an expression of increased intracranial pressure it cannot be specifically localized. The author believes that vertigo occurs in the presence of increased intracranial pressure only when there is involvement by way of the internal auditory canal of the vestibular nerves or the labyrinth (stasis of the labyrinth). He has demonstrated that in many cases of increased intracranial pressure, marked compression of the brain stem and frank hydrocephalus evidence of vertigo did not appear.

- A. The greatest degree of vertigo occurs when the root fibers of the vestibular nerve in the efferent nerve or the descending root and the arcuate fibers, which follow the nucleus to the posterior longitudinal fasciculus, are involved either directly or indirectly.
  - B. An isolated lesion of the posterior longitudinal bundle, in the region of the narrow vestibular system, can produce marked vertigo.
  - C. A lesion in the course of the ascending vestibular root fibers (the ipsilateral corner of the fourth ventricle) to its entrance into the nucleus angularis (Bechterew) leads to definite vertigo.
  - D. An isolated lesion in the nucleus vestibularis triangularis, at least in its dorsal portion, either unilateral or bilateral, does not produce any vertigo.
  - E. A lesion which unilaterally destroys the entire central vestibular system causes vertigo for a long time.
  - F. If the pathologic process reaches into the fourth ventricle, as hydrocephalus, a cysticercus cyst or involvement of the choroid plexus, it usually does not cause any vertigo. Vertigo occurs only when the vestibular system is involved directly by an encroaching process from above or there is involvement in the medulla. This is also true of any process occurring in the cerebellum. Here the disease must involve either the vestibular nerve or its tract.
  - G. A lesion in the midbrain does not produce vertigo, unless it encroaches on the narrow vestibular system. An involvement of the posterior longitudinal bundle in this region likewise does not produce vertigo.
  - H. What has been said of the midbrain under G, applies also to the diencephalon and the root ganglion.
  - I. The author has been unable to find any positive evidence of a localization sign for vertigo in the cerebrum. This is in spite of statements in the literature that there are areas in the parietal and temporal lobes lesions in which are associated with vertigo.
- II. Uniphasic reaction. This means that after stimulation either caloric or rotary, instead of true nystagmus, a slow component occurs, such as conjugate deviation of the eyes in the direction of the slow component. This may be due to interference somewhere in the ocular system.
- III. No response from the vestibular system. The lesions usually occur in the pons, especially in the region of the posterior longitudinal bundles.
- IV. Spontaneous nystagmus. Persistent rotary or horizontal-rotary nystagmus always suggests a central lesion. Spontaneous nystagmus in the direction of a dead labyrinth is always of central origin. This is especially true when vertigo is not associated. Postural nystagmus has been found in 40 per cent of 150 cases of tumor of the brain, and in 80 per cent of these the growth was in the posterior fossa. This definite localization has not been established. Hence, it is not of practical value.
- V. Abnormal deviation of the head and body. The lesions have been found to be related to the vestibular system, in fact, related to the anterior corpora quadrigemina, at the level of the third ventricle. It is apparent also that a lesion in the frontal and temporal lobes of the cerebrum may produce this symptom. However, a positive diagnosis is not possible, but it is definitely known that the labyrinth, the vestibular nerve or its primary end organs and the brain stem are responsible for the phenomenon.

In summarizing, the author groups the symptoms as follows:

- A. Symptoms arising from part of the acoustic nerve which suggest a lesion of the central nervous system.



1. Severe attacks of dizziness, which may be recurrent, in the presence of normal hearing.
  2. Evidences of severe excitability of the vestibular nerve, either unilateral or bilateral, also in the presence of normal hearing.
  3. Persistent spontaneous nystagmus in the presence of normal hearing.
  4. Severe headache or an increase of preexisting headache occurring simultaneously with severe dizziness.
  5. All forms of abnormal reactions previously described, especially preponderance of the slow component and any disturbance of the rhythm of nystagmus.
  6. Postural nystagmus.
  7. High grade nystagmus without dizziness or, if dizziness is present, with mutual independence of both symptoms.
- B. Symptoms arising from the acoustic nerve which are signs of a lesion of the central nervous system.
1. Unilateral deafness and a dead cochlea plus spontaneous nystagmus to the same side.
  2. Nystagmus continuing in the same direction unchanged for longer than a week.
  3. Pure rotary nystagmus existing for a long period.
  4. Vertical nystagmus of any form.
  5. Unilateral or bilateral caloric unexcitability in the presence of normal rotary responses and normal hearing.
  6. Uniphasic reactions.
  7. Periods of deafness together with loss of consciousness.
  8. Persistent changes of the posture of the head during examinations of the vestibular nerve, occurring at times in association with somnolence or sleep.

Under his last division, he presents a series of diagrams, presenting various lesions, which in turn elicited certain definite symptoms.

In conclusion, he emphasizes the desirability of close cooperation between the otologist and the neurologist, since a differential diagnosis often is impossible without such cooperation.

PERSKY, Philadelphia.

PETROSITIS AND HORNER'S SYNDROME. P. H. GERLINGS, *Acta oto-laryng.* **27**:561, 1939.

Gerlings presents 2 cases in which Horner's syndrome complicated petrositis. Serial sections of the temporal bone in 1 of the cases revealed infection and formation of an abscess in the peritubal cells and an actual abscess in the carotid canal. The Horner syndrome was caused by involvement of the sympathetic plexus in the carotid canal.

GROVE, Milwaukee.

## Pharynx

SUBLINGUAL ABSCESS OF CITELLI. G. GIUFFRIDA, *Arch. ital. di otol.* **51**:293 (June) 1939.

Citelli established the fundamental characteristics of sublingual abscess which distinguish it from other suppurative processes of the mouth and neck. Sublingual abscess occurs in the loose connective tissue lateral to and beneath the

sublingual gland. The floor of this region is formed by the mylohyoid muscles, and they do not shut it off completely from the submandibular region. The fundamental symptoms of sublingual abscess are pain, difficulty of swallowing and mastication, dysarthria and tumefaction of the floor of the mouth, of part of the inferior surface of the tongue, of the median suprahyoid region and of the submandibular region. The swelling in the floor of the mouth is cordlike and is marked at the sublingual fold. It is distinguished from Ludwig's angina by being unilateral and involving the anterior part of the floor of the mouth and the under surface of the tongue. It is only in cases in which the process is not promptly treated that it extends to the suprahyoid region. Six cases are reported, in all of which a gram-positive diplococcus was found in the pus. In 2 cases the abscess was caused by puncture of the mucosa by vegetable fiber. Dental infection is a frequent cause of the abscess. The preferred treatment is by incision of the floor of the mouth and daily probing thereafter. The suprahyoid swelling does not subside immediately. It is well to wait a few days before determining the necessity of drainage by the external route.

DENNIS, San Diego, Calif.

THE OXIDE-REDUCING POWER OF THE TONSILLAR TISSUES. F. VENTURA-GREGORINA, Arch. ital. di otol. **51**:437 (Sept.) 1939.

Using the method of Birch, Harris and Ray (2,6-dichlorophenolindophenol), Ventura-Gregorina studied the oxide-reducing power of tonsillar and adenoid tissue removed from 40 patients varying in age from 3 to 38 years. Especially considered was the relation of reduction oxides to the age of the patient and to the histopathologic structure of the tonsillar tissue. The results of the investigation indicate that when lymphatic hypertrophy is greater the oxide reduction is of higher value. In children up to the fourteenth year there is a greater degree of lymphatic hypertrophy than in adults and a larger extent of germinative centers, accompanied by a smaller quantity of stromal tissue. It also appears from the research that in the hypertrophic, chronically inflamed and hyperplastic tonsils, the important biologic phenomena of tissular respiratory activity progressively diminishes in relation to various complex factors, including, particularly, biochemical influences.

DENNIS, San Diego, Calif.

## Nose

NASAL OBSTRUCTION CAUSED BY COLLAPSE OF THE NASAL ALAE. HAROLD I. LILLIE and KINSLEY M. SIMONTON, Ann. Otol., Rhin. & Laryng. **48**:600 (Sept.) 1939.

Alar collapse is a condition often not considered in looking for the cause of nasal obstruction. It is more frequently the cause than is generally recognized. It may be produced by overactivity of either the constrictor or the dilator muscles of the alae and is influenced by the negative pressure produced in the nose by inspiration. Other possible causes for the obstruction should be ruled out. In alar collapse the patient "breathes with the nose, not through the nose"; inspirations are short and quick; the alae are partly or wholly drawn inward. The effort of the patient to draw air into the nose increases the degree of medial motion while long, slow inspirations diminish the tendency to collapse. If a cotton ball tucked into the anterior superior recess of the vestibule gives complete relief, the diagnosis is made.

Some patients, when the cause of the obstruction is pointed out, will be able to correct the condition by correcting the air breathing. In some cases a cotton ball will be used; in others, a silver tube shaped to fit the vestibule. If simpler methods do not suffice, various surgical procedures may be tried.

M. V. MILLER, Philadelphia.

THE RATIONAL TREATMENT OF SINUSITIS IN CHILDREN. JOHN J. SHEA, J. A. M. A. 113:10 (Sept. 2) 1939.

The author discusses the various forms of treatment of the sinuses. He reviews the local measures performed in the office, here and there adding a personal observation. Some comments are made on medicinal therapy, when to irrigate a sinus, questions of diet, climate, immunization, electrotherapy and surgical intervention.

He concludes as follows: 1. The rational treatment of sinusitis depends on a sane appreciation of the more recently discovered anatomic and physiologic facts, the result of clinical and experimental studies. 2. The treatment of sinusitis in children differs from that in adults in that the rhinologist hopes to terminate their infections or correct their allergic disturbances, thus obtaining a permanent cure.

GORDON, Philadelphia.

VOLUMINOUS PAPILLOMA OF THE NOSE, MAXILLARY SINUS AND NASOPHARYNX. G. SALVADORI, Arch. ital. di otol. 51:356 (July) 1939.

The malignancy of nasal papillomas has been widely discussed. The opinion of Massione that papillomas are histologically benign but that in some cases the clinical course is malignant is not accepted. The patients do not have metastases or cachexia; the vigorous epithelial development of the tumor, the tendency to recur and the rich blood supply account for the apparent malignancy.

Salvadori believes that either the so-called malignant papillomas are papillary epitheliomas from the beginning (not thoroughly examined histologically) or, although initially papillomas, they have undergone malignant degeneration. In support of his views he reports 2 cases, 1 published in 1928 and 1 in this article. From a clinical point of view, both growths were benign, because there has been no recurrence; notwithstanding their long course (seven years and twenty years, respectively) and extensive development, there were only local symptoms of compression and no disturbance of the general condition. Histologically, the epithelium in 1 case was flat, with fibrous connective tissue and moderate vascularization; in the other case the epithelium was cylindric and the connective tissue was loose, edematous and rich in blood vessels. Both growths were pure papillomas, without atypical cells or karyokinesis and with a clear demarcation between layers of epithelium and of connective tissue. In pure papillomas, the sole factor that suggests malignancy is recurrence. Salvadori suggests that recurrence may be due to incomplete removal because the external method of operation was not used.

DENNIS, San Diego, Calif.

TRUNCULAR (BLOCK) ANESTHESIA OF THE NASAL CAVITY. GATTI-MANACINI, Arch. ital. di otol. 51:495 (Oct.) 1939.

Gatti-Manacini describes the distribution of the nerve supply of the nasal cavity and the technic of injection of the nerve trunks. The sphenopalatine ganglion is approached through the posterior palatine canal and the anterior nasal (ethmoid) nerve through the orbit at the level of the anterior ethmoid foramen. The advantages of the procedure are complete anesthesia with a minimum of time, the use of a minimal amount of anesthetic and only a slight degree of shrinkage of the mucosa. When shrinkage and ischemia of the mucous membrane are required, a small amount of epinephrine solution may be applied locally. The method is indicated in all operations in the nasal cavity and the sinuses.

DENNIS, San Diego, Calif.

RHINITIS UNDER CONDITIONS OF SLEEP. H. TSUKAMOTO, T. HIRUGAWA and Y. KURITA, Monatschr. f. Ohrenh. 73:380 (June) 1939.

With simple coryza, normal sleep under proper cover never produces the same increase of pathologic symptoms as does the horizontal position in the period of

wakefulness, viz., increase of the discharge, but, on the contrary, a relief. This may be caused by a diminution of the hyperesthesia, a decrease in the secretion and other effects of the heat-regulating mechanism of the body, which is affected by the steady environment of a warm bed. The decrease of glandular secretion in the nose and also in the larynx during sleep may also be the cause of morning hoarseness in acute dry laryngitis and of the increase of complaints in dry rhinitis after a night's rest.

LEDERER, Chicago.

### Miscellaneous

END-RESULTS OF IRRADIATION OF THE THYMUS GLAND IN TWENTY-FOUR NORMAL INFANTS AND CHILDREN. C. G. KERLEY, *Am. J. Roentgenol.* **40**:416 (Sept.) 1938.

In 24 cases an attempt was made to determine the therapeutic results and absence of harm to mental or physical development of irradiation of an enlarged thymus.

The diagnosis was made by a roentgenogram of the chest and a history of sudden alarming attacks of dyspnea with cyanosis in an infant who otherwise was healthy.

In 21 cases the age at the time of treatment was less than 1 year. The weight and height of all the children except 2 were above the standards.

The author concludes that if the child is normal irradiation of the thymus produces no retardation of physical growth or of mental development.

SQUIRE, Chicago. [*AM. J. DIS. CHILD.*]

PROPHYLAXIS IN ALLERGY. R. A. KERN, *Ann. Int. Med.* **12**:1175 (Feb.) 1939.

After a discussion of the known facts relative to the production of sensitivity in those so predisposed, Kern offers as a means of preventing sensitization of the fetus in utero the avoidance of overindulgence in foods by the pregnant mother.

Prevention of sensitization to inhalants is accomplished by attention to the sleeping quarters, choice of toys, pets and furniture.

The importance of selecting a suitable occupation is urged on the allergic person.

Special care should be exercised in the selection of places for vacations with reference to plant pollination.

It is suggested that attempts at prophylaxis against hypersensitiveness should be made for the child with an allergic parent, for the person who has had allergic manifestations in the past, for the person who at present has some minor allergic symptom and for the one with obvious allergic disease.

It is estimated that 15 per cent of the white population of this country is allergic.

READING, Galveston, Texas. [*AM. J. DIS. CHILD.*]

THE ETIOLOGY OF TRAUMATIC MENINGITIS: A SURVEY OF NINETY CASES IN WHICH THE CONDITION WAS VERIFIED AT AUTOPSY. CYRIL B. COURVILLE and C. DON PLATNER, *Bull. Los Angeles Neurol. Soc.* **3**:150 (Dec.) 1938.

The cause and pathogenesis of pyogenic meningitis following trauma constitute a complex problem which involves much more than the direct extension of organisms into the cranial cavity through a fracture. Courville and Platner made a study of 1,261 cases of fatal craniocerebral injury, in 76 of which meningitis was discovered at autopsy, an incidence of about 6 per cent. This figure is in accordance with the observations of others on the incidence of meningitis following ultimately fatal injury to the head in civil life, although the percentage varies between 18 and 35 in war. Courville and Platner constructed the following classification of their cases on an etiologic basis: 1. Meningitis after basal fracture involving the nasal cavities, the sinuses or the auditory canal. In this, the largest

group, there were 61 cases, of which the fracture was in the anterior fossa in 31, in the middle fossa in 17 and in both the anterior and the middle fossa in 13. Only 4 of the 61 patients were female. 2. Meningitis after compound depressed fractures of the vault, 5 cases. 3. Meningitis after penetrating wounds of the skull, 3 cases. 4. Meningitis after injuries to the head without fracture, 9 cases. In this interesting group the path of invasion was usually not evident, but it seemed to be from an infected wound in the scalp, the nasal sinuses or the ear through emissary veins into the skull. 5. Meningitis secondary to traumatically precipitated sinusitis, otitis or mastoiditis, 4 cases. 6. Meningitis following injury to the spine, 2 cases. 7. "Metastatic" meningitis secondary to traumatically induced suppurative foci elsewhere in the body, particularly in the thorax, 5 cases. 8. Meningococcic meningitis precipitated by injury, 1 case. The possibility of tuberculous meningitis precipitated by injury is mentioned; no such case, however, was found in the series, and Courville and Platner consider its entity to be uncertain. They state that meningitis induced by trauma may be immediate, primary or direct, or delayed, secondary or indirect. Indirect or secondary meningitis follows some other suppurative intracranial lesion. Delayed meningitis is due to extension of infection through a fracture at least three weeks after the injury.

The treatment of this type of meningitis consists largely of prevention, in discussing which Courville and Platner mention adequate antisepsis of wounds in the scalp, gentle handling of patients, avoidance of irrigation or examination of bleeding ears, great care in exploring compound depressed fractures and the avoidance by the patient of blowing the nose, coughing, sneezing or straining. The patient should be kept on his back with his head slightly elevated. Administration of sulfanilamide is mentioned.

MACKAY, Chicago. [ARCH. NEUROL. & PSYCHIAT.]

LEPROSY OF THE UPPER RESPIRATORY TRACT: DISCUSSION OF EARLY AND MODERATELY ADVANCED CASES. F. J. PINKERTON, J. A. M. A. **111**:1437 (Oct. 15) 1938.

Pinkerton reviews his experience in Hawaii in the study of leprosy patients for lesions in the upper respiratory tract. He states that practically every patient with leprosy has some nasal lesion due to the disease. Dryness, stuffiness, excessive crusting, blocking and epistaxis are common symptoms. The nasal bone is never destroyed, but the nasal cartilage commonly shows the typical depression at the tip of the nose; in a patient with syphilitic saddle nose the depression is due to destruction of the bony septum. The pharynx is seldom attacked. Nodules, leukoplakia and diffuse thickening may be lingual manifestations of leprosy. The tonsils were found to be affected in 20 per cent of cases, and in 40 per cent of cases of moderately advanced nodular involvement there were leprosy lesions of some kind in the larynx. Huskiness may be an early symptom. In making a nasal "snipping" for bacteriologic examination, scraping hard enough to get some of the epithelium is essential, but one should not scrape hard enough to draw blood, as this interferes with the further examination. The scrapings are stained by the Ziehl-Neelsen technic. The favorite site for scraping is the septum, near the anterior border, or the side of the nose, immediately above the anterior end of the inferior turbinate. According to Pinkerton, more than 40 per cent of leprosy patients with nodular lesions show a positive Wassermann reaction. With progression of the disease, the tendency to positivity of the reaction increases. In the neural types the Wassermann reaction is not specifically affected. Pinkerton has not observed any specific therapeutic effect from chaulmoogra oil U. S. P. Leprosy lesions in the upper respiratory tract are best treated by measures to improve the general health, the use of bland oil sprays and hygienic care.

LEWIS, New York. [ARCH. DERMAT & SYPH.]

MENINGITIS CAUSED BY STREPTOCOCCUS HAEMOLYTICUS AND TREATED WITH SULFANILAMIDE. JOHN A. TOOMEY and E. ROBBINS KIMBALL, J. A. M. A. **112:2586** (June 24) 1939.

The authors discuss in moderate detail their 12 cases of streptococcic meningitis and comment on several series of cases reported by others. The bibliography contains sixteen references.

Their procedure is "(1) to give a massive initial dose of . . . [sulfanilamide] followed at once by frequent maintaining doses, (2) to have the patient operated on as soon as possible for removal of the focus of infection and (3) to leave the hydrostatics of the spinal fluid alone unless the pressure is extremely high."

They stress the following point: "Sulfanilamide alone may prolong the life of the patient ill with streptococcic meningitis but it will not give complete cure if there is an unattended focus of infection." When the focal point of the disease was not recognized, the condition remained stationary.

They conclude: "Sulfanilamide is the therapy of choice in treating patients with beta hemolytic streptococcus meningitis. However, it is equally important to drain any localized area of infection by proper surgical procedures."

GORDON, Philadelphia.

# Society Transactions

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## CHICAGO LARYNGOLOGICAL AND OTOLOGICAL SOCIETY \*

GEORGE T. JORDAN, M.D., *President*

WALTER H. THEOBALD, M.D., *Secretary*

*Regular Monthly Meeting, Dec. 4, 1939*

### Mucocele of the Frontal Sinus. DR. J. A. WEISS.

This article will appear in full in a later issue of the ARCHIVES.

### Paralysis of the Abducens Nerve Associated with Sinus Thrombosis. DR. LEO A. SATZ.

When the patient, a white boy aged 13, was first seen, twelve days after a paracentesis on the right tympanic membrane, he complained of pain behind the right ear and in the zygomatic region and of right-sided headaches. The temperature on admission was 100.8 F. There was leukocytosis, the white cell count being 17,000.

The symptoms of sinus thrombosis were latent, and the paresis of the abducens nerve appeared ten days after an operation on the sinus.

Although some of the clinical symptoms along with the roentgenographic findings pointed to possible involvement of the petrous tip, the lack of continuous orbital pains, the moderate discharge from the wound, as well as the excellent healing tendencies throughout the entire period, the good physical condition of the patient and the late appearance of the paresis made the decision difficult.

The clinical picture, including the paresis of the external rectus muscle, could have been caused either by an osteitis in the petrous tip resulting from the diffusion of the infection in the tympanum along preformed anatomic pathways or by diffusion of periphlebotic changes along the inferior petrosal sinus, producing edema in the tissues surrounding Dorello's canal. The latter pathway, although rare, has been mentioned in the literature, especially as being the route followed in cases of abscess in the neighborhood of the sigmoid sinus. Considering that an inconstant paresis of the abducens nerve occurred after a sinus thrombosis and that low grade fever and leukocytosis persisted, it may be that involvement of the inferior petrosal sinus was responsible for the clinical picture. This and the absence of other threatening symptoms being kept in mind, surgical intervention was withheld.

#### DISCUSSION

DR. CARL CHRISTOPH: I should like to compliment Dr. Satz on his excellent presentation of a difficult case. In the differential diagnosis, meningitis, abscess of the brain and involvement of the inferior petrosal sinus or of the cavernous sinus were considered. The patient had two important symptoms of petrositis, headache and paralysis of the sixth nerve. The headache was deep seated and was not typically located behind the eye. The paralysis of the sixth nerve, while present, fluctuated in degree. It was a paresis rather than a paralysis. Thrombosis of the petrosal sinus seemed likely. The only explanation for the paralysis was on the basis of the edema.

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\* The program was presented by the members of the staff of the Illinois Eye and Ear Infirmary.

As for treatment, watchful waiting was considered the best course. The fact that the patient made an uneventful recovery showed the wisdom of being conservative.

DR. BENJAMIN BOSHERS: This patient had a stiff neck, and the differential diagnosis between a stiff neck and a meningeal neck had to be made. Ordinarily, when a neck is meningitic the patient permits the examiner to rotate the neck from side to side. In this case when rotation of the neck was attempted the boy complained of pain. The absence of confirmatory signs, like the Kernig sign, further indicated that this was not a meningitic neck.

The second point was the nature of the invasion from the ear. The possibility of an abscess of the temporoparietal lobe or of an epidural abscess was considered. In the absence of choked disk, a space-occupying lesion could be excluded. The absence of a hemianopic defect ruled against a lesion in the temporal lobe. There was no adiadokokinesis. The presence of a palsy of the sixth nerve suggested a lesion within the cranium. If it had been an intrapontile paralysis it would have picked up the seventh as well as the sixth nerve. Pain in the anatomic distribution of the fifth as well as the sixth nerve spoke for a lesion at a point where the two are contiguous. Consequently, the impression was that the anomaly was what the neurologist calls the "paratrigenial syndrome," a lesion located in juxtaposition to the ganglion of the fifth nerve. Since the impression was that there was no abscess or space-filling lesion and that meningitis was not present, it was concluded that the lesion must be local, near the tip of the petrosa.

I think the differentiation between "stiff" neck and true meningitis neck has value, because many times a patient is so sick that one is reluctant to do a spinal puncture. Such small signs are useful in the differential diagnosis.

#### Complication of Caldwell-Luc Operation. DR. BERNARD M. COHEN.

A Negro woman aged 40 entered the clinic in 1937, complaining of frontal headaches and of aching in the teeth off and on for the past thirty years. Several irrigations of both maxillary sinuses were performed, and she did not return until 1939, when she had a recurrence of these symptoms, the pathologic condition being most marked on the left side. Roentgen studies of the sinuses showed extensive cloudiness in the antrums and hypertrophic mucosal changes, noticeable most on the left side. Irrigation of the left maxillary sinus failed to produce improvement.

On May 15, 1939, a Caldwell-Luc operation was performed on the left side; a great deal of polypoid tissue was removed from the antrum, and a counter-opening was made into the nose in the inferior meatus and a rubber tube drain inserted.

The early postoperative condition was satisfactory except for severe pain in the left side of the face referred particularly to the preauricular region. On the fourth postoperative day the patient had a chill and a temperature of 104 F. The following day a definite circumscribed swelling of the parotid gland developed, associated with redness and marked tenderness. (The antral washings continued clear.) A diagnosis of surgical parotitis was made and roentgen treatment given over the swollen area.

The fever continued, a slight fluctuation developed in the parotid gland, and on the eleventh postoperative day the gland was incised and searched in vain for pus. In forty-eight hours, however, there was profuse drainage of foul material from this incision and a bulging of the left side of the soft palate and of the lateral pharyngeal wall was found. This swelling was incised and the same foul pus encountered. Subsequent irrigation through either incision caused a flow through the other incision; the diagnosis of infection of the pharyngomaxillary fossa was therefore established. For the next three days fever subsided and the condition improved, but the fever soon recurred. On the twenty-first postoperative day an incision was made along the left sternocleidomastoid muscle, the carotid sheath exposed, the pharyngomaxillary fossa entered and pus drained. The internal jugular vein was ligated and cut.



The temperature gradually returned to normal, and progress was satisfactory. However, on the thirty-second postoperative day a fluctuant swelling developed in the midline of the neck just above the sternal notch. This was incised and foul pus encountered.

Subsequently, all incisions healed, with subsidence of drainage. The patient had no complaints. On the fifty-third postoperative day she was found in a deep stupor, having a temperature of 104 F. and a pulse rate of 132. The neck was rigid. The Babinski and the Kernig sign were positive. The spinal fluid was under increased pressure and was cloudy; the cell count was 1,200, with polymorphonuclears predominating. Within a few hours, the patient lapsed into a deep coma and died.

The patient in this case presented suppurative surgical parotitis following the Caldwell-Luc operation, with the products of inflammation breaking through the deficient portion of the parotid fascia. This produced infection of the pharyngomaxillary fossa, and the infection descended and ascended from the original site. Descent was adequately halted by the surgical procedures, but the ascending infection to the meninges caused the fatal termination.

#### DISCUSSION

DR. SAMUEL SALINGER: Why was the parotid gland invaded in the first place? It seems more than likely that the infection was transmitted by direct extension either through the original incision or through Stenson's duct. Usually in doing a Caldwell-Luc operation one forgets the parotid gland, but it can be easily traumatized, especially by too vigorous application of retractors. Once the infection enters the parotid gland it can pass to the pharyngomaxillary space, which is in close apposition to its medial surface. Only last summer I observed a case of parotid infection following a pelvic operation; in that case there was a subsequent terrific infection of the pharyngomaxillary sinus, which was drained by the Mosher procedure. Once the infection has reached the pharyngomaxillary space it can invade the carotid sheath and proceed thence down to the sternum, as it did in Dr. Cohen's case. An ascending infection is less frequent but can take place by way of the carotid artery or the pterygoid venous plexus. This is the first time I have seen a complication of the type, and I believe it interesting enough to be placed on record.

DR. JOSEPH BECK: Dr. Salinger called attention to the fact that infection of the parotid gland is reported, but the anomaly is not well known to most otolaryngologists; particularly unfamiliar is the point that Dr. Salinger made regarding trauma from retractors. I had a patient with paralysis of the facial nerve following an operation of this type, and I believe that the condition resulted from the use of retractors to get to the back part of the antrum in the removal of the osteal wall.

In cases in which general surgical procedures are employed, infections go to the parotid gland or from the parotid gland to the rest of the body, especially after gunshot wounds. Many cases, notably that of President Garfield, have been reported in which infection of the parotid gland followed a gunshot wound. I think Dr. Cohen's presentation is valuable, and since the Caldwell-Luc operation is so frequently done attention should be called to the possibility of trauma.

#### Nasopharyngeal Tuberculosis. DR. F. PISZKIEWICZ.

C. B., a Negro youth aged 17, was admitted to the outpatient clinic on Sept. 11, 1939. He gave a history of bilateral deafness and tinnitus of about nine months' duration, stating that about nine months ago a swelling on the right side of the neck started as a small painless nodule which gradually grew in size to that of a walnut and then ruptured spontaneously and discharged a thin whitish fluid. This sore remained open and discharging for about two weeks, became crusted over and healed. About one month after the appearance of the swelling in his neck he noted that his hearing began to fail. The hearing loss developed rapidly and to such a marked degree that he was compelled to leave school.

On examination the right ear drum appeared thickened and reddened and the left external auditory canal contained some yellowish white discharge, which seemed to be coming from a small anterior perforation in the ear drum. There was an asymmetric enlargement of the posterior cervical lymph glands, the right chain being larger and less discrete. There was no tenderness or fluctuation, and on the right side of the neck the skin presented two small dimpled scars. The tonsils were moderately enlarged. The soft palate, uvula and anterior pillars were infiltrated and of a leathery consistency. The posterior pharyngeal wall contained several enlarged, raised, reddish masses of lymphoid tissue. Digital examination of the postnasal space showed it to be narrowed and containing a soft spongy mass which bled easily.

The blood count was normal. The hemoglobin value was 91 per cent. The Wassermann reaction of the blood was negative. The Mantoux test elicited a strongly positive reaction. There was bilateral deafness to the ordinary conversational voice; the limit for the lower tones was 256 cycles and for upper tones 1,024. Stimulation of both labyrinths by cold alcohol resulted in normal responses. A biopsy of the nasopharyngeal tissue was reported as revealing tuberculous granulation tissue. Roentgen examination of the chest showed no abnormal findings. The cervical vertebrae appeared normal on roentgen examination. Specimens of sputum were repeatedly normal when examined for tubercle bacilli. The patient was referred to the tumor clinic, where he received small doses of roentgen radiation for twelve days, a total of 66 roentgens being given.

Reexamination three weeks after the administration of roentgen therapy showed an almost complete absence of lymphoid tissue in the mouth and pharynx and no mass in the nasopharynx. The soft palate was thickened and leathery hard, and the regions of both eustachian orifices were firm and infiltrated. The hearing showed no material improvement, and the left ear was moist. After the original biopsy, more tissue was removed for further study and for guinea pig inoculation. Smears of this tissue failed to reveal tubercle bacilli.

*Conclusion.*—This is a case of nasopharyngeal tuberculosis associated with bilateral lymphadenitis, probably tuberculous, and bilateral deafness. No pulmonary or tracheobronchial tuberculous lesion could be demonstrated. Further studies are being carried out to determine the nature and type of tuberculosis.

#### DISCUSSION

DR. ALFRED LEWY: This patient was sent to the tumor clinic in the belief that the disease was nasopharyngeal fibroma, because I thought the mass felt hard. A report on the guinea pig inoculation is not yet available. The slide appears characteristic. The boy's general condition is much better. He has grown 3 inches (7.5 cm.) in height, is much heavier and has a great deal more energy than when I first saw him. It is not known where this tuberculosis originated, whether it arose in the cervical glands and then by a retrograde process appeared in the nasopharynx, or whether it began at another site. The loss of hearing suggested that the infection of the middle ear may also be tuberculous. This loss of hearing was rapid. I shall know more about the patient after the study of the guinea pig inoculation is complete.

DR. FRANCIS L. LEDERER: The epipharynx is seldom the site of primary tuberculosis, and when the lesion is in this area there is usually chronic pulmonary tuberculosis. This particular area is of significance from a diagnostic and therapeutic point of view, for often it, as well as the pharynx, is a focus for reinfection of the ears, since the lymphatic tissue of the epipharynx is part of Waldeyer's ring. This patient had cervical adenitis, a remnant of the old scrofulous type of infection. In a number of patients with this condition fistulous tracts have formed, going back into the nasopharynx and communicating with the adenitis, which is the primary source of infection. A more complete history might establish the fact that it is an acid-fast type of infection, as Dr. Lewy intimates. Osteomyelitis of the cervical part of the spine on a tuberculous basis is also a possibility.

This case proves again what has been emphasized in the past, namely the necessity of close observation of the epipharynx as a source of tuberculosis. There are two types of tuberculosis observed at that site. The first is the more chronic type. The second type usually seen in this area is the miliary form of tuberculosis associated with the laryngeal form when the pulmonary tuberculosis is primary. These conditions often accompany tuberculosis in Peyer's patches of the intestines. Tuberculous enteritis develops in association with this particular condition. However, I believe that this case cannot be looked on as one of primary tuberculosis of the nasopharynx but should be considered as a case of tuberculosis secondary to cervical adenitis.

DR. SAMUEL SALINGER: The condition in this case presented a typical triad of symptoms which might lead one to believe it malignant. The patient had aural symptoms, a mass in the nasopharynx and enlarged cervical glands. Two facts, however, would rule out carcinoma: First, the symptoms developed rapidly; second, the lymph glands broke down early. These never occur in cases of malignant growth. The only other condition that might behave the same way is actinomycosis. It is speculation to try to figure out whether the infection was primary in the nasopharynx or secondary to an infection of the cervical glands. I am more inclined to believe that this patient had an old primary tuberculosis in the chest and that the nasopharynx was involved by metastatic infection together with secondary invasion of the glands.

#### Two Cases of Labyrinthitis. DR. FREDERIC J. POLLOCK.

This report covers the cases of 2 patients who had labyrinthine involvement associated with otitis media.

The first patient was a man aged 35 who complained of deafness and tinnitus in the right ear for six weeks. Eleven days before his admission to the clinic a postauricular swelling developed and there was discharge from the right ear. The tympanum was intact, but there was a fistula in the posterior wall of the external auditory canal. The distance at which the voice could be heard was reduced to 1 foot (30 cm.). The Rinne test elicited a negative reaction, and in the Weber test the sound was lateralized to the affected ear. Rotation tests showed that both labyrinths were normal. The Wassermann reaction of the blood was negative.

Although external otitis with a postauricular abscess was suspected, the roentgenogram showed extensive destruction in the mastoid cells. A simple mastoidectomy was done; a fistula was found in the cortex and another in the posterior wall of the external auditory canal. A pneumatic mastoid process was observed, with broken-down cell walls and filled with granulations. Culture showed a mixture of organisms, with *Staphylococcus* overgrowing the others.

Recovery was uneventful, except for continuance of a postauricular discharge. Five weeks later, while still under care, dizziness, headache, nausea and vomiting developed, as well as tinnitus followed by deafness, horizontal rotatory nystagmus of a second degree to the opposite side and past pointing. There were no signs of meningeal involvement. The temperature was 99.2 F. Caloric tests showed a dead labyrinth on the affected side. A lumbar puncture revealed 20 cells, of which 90 per cent were lymphocytes. The pressure of the spinal fluid was normal. Administration of 90 grains (5.4 Gm.) of sulfanilamide daily was begun, and the following day the temperature became normal and the nystagmus considerably less marked; the patient felt much better. Another lumbar puncture two days later showed 15 cells. The administration of sulfanilamide was continued in doses of 60 grains (3.6 Gm.) daily. The patient continued to make an apparent improvement.

Ten days after the onset of the labyrinthitis, a temperature of 104 F., a severe headache and a stiff neck suddenly developed. Lumbar puncture showed 3,500 cells, and a culture revealed streptococci. A roentgenogram showed no involvement of the petrous apex. A radical mastoidectomy was done, the semicircular canals

were opened, and the wall of the promontory was broken through. The patient died four days later. No autopsy permit was obtained.

The second patient was a man aged 26 years, who had had a purulent discharge from the left ear since he was 1 year old. For ten days before admission he had noted a dull pain over the left mastoid process, and for three days he had had vertigo and nausea. The temperature was 100 F. A spontaneous second degree nystagmus to the right was noted. Examination showed an almost complete obstruction of the drum, as well as a middle ear filled with granulations; roentgen studies revealed a large cholesteatoma. Hearing in the affected ear was limited to conversation on contact, with masking of the other ear. In the Weber test the sound was lateralized to the good ear. The fistula test did not increase the nystagmus. There were no signs of meningeal involvement. A Wassermann test of the blood gave a negative reaction. Conservative treatment was given, and the temperature gradually returned to normal. All hearing disappeared, except that by bone conduction. A slight facial weakness became apparent. The dizziness and nausea disappeared, and nystagmus could no longer be elicited. Three weeks after the onset of the labyrinthine storm, rotation tests showed a dead labyrinth and all hearing, both by ear and by bone, was gone. The patient was discharged from the hospital.

Nine days later he was again admitted, because of headaches and elevation of temperature. A lumbar puncture showed 70 cells, mostly lymphocytes, and there was a positive reaction to the Pandy test for globulin. A Wassermann test was reported as giving a 4 plus reaction, and the Lange gold curve indicated *tabes dorsalis*. Antisyphilitic therapy was instituted. Two months after this treatment was begun, all symptoms cleared up and the spinal fluid showed 24 lymphocytes and a negative Wassermann reaction but a positive gold curve.

This patient was last seen on Nov. 21, 1939, about eleven months after he first came under observation. He still had a foul discharge from his left ear. Hearing was completely gone, and no response could be elicited from irrigation of the ear with ether.

*Comment.*—These two cases had certain points of similarity. In both, there were a dead labyrinth and a spinal fluid cell count above normal. The first patient had no discharge from the middle ear, yet a mastoid suppuration developed. This infection eroded the cortex and the posterior canal wall.

#### DISCUSSION

DR. M. A. GLATT: It is often difficult to differentiate clinically the serous from the purulent type of labyrinthitis or to foretell whether the pathologic process in a latent type is fibrosed or is lingering.

In the first case, in view of the improvement in symptoms and decrease of spinal fluid cells, it appeared that recovery might take place and conservative treatment was justified. On the other hand, when one considers the late onset of the labyrinthine symptoms in a case of acute suppuration of the middle ear associated with an intact ear drum, followed by an atypical form of mastoiditis, then one realizes that the prognosis was grave and may assume that probably an earlier exploration of the labyrinth was indicated.

The condition in the second case is an example of the circumscribed type which gradually progresses into a latent form of labyrinthitis. The history of a chronic aural discharge and the mild recurrent attacks of labyrinthitis offered a better prognosis. The delay in performing the mastoid operation was due at first to the acute exacerbation of the otitis and then to the discovery of an associated syphilitic infection and to the patient's refusal.

At the time of operation the management of the labyrinth depends on the findings. If intact, it should be left alone. Should signs of meningeal irritation arise postoperatively, immediate exenteration of the labyrinth is indicated. However, when it is found that the cholesteatoma has invaded the labyrinth capsule or when the removal of granulation tissue will uncover the labyrinth, then the latter should be exenterated at the same time.

The conservative or the radical management of labyrinthitis in a particular case depends on many factors, such as (1) cause, (2) a history of trauma or infection, (3) whether there is associated acute or chronic suppuration of the ear, (4) the condition of the mastoid process and the contiguous structures, particularly the bony labyrinth at the time of operation, and (5) the findings of the cerebro-spinal fluid.

DR. HANS BRUNNER: I have not seen this patient and can speak only about labyrinthine operations in general. When I began the practice of otolaryngology many labyrinthine operations were being done. Later the number decreased, and in the last years sometimes many months passed without one being done in our clinic. This decrease in the number of labyrinthine operations is not limited to my own experience. The fact must be borne in mind that there is a difference in the development of chronic otitis and in that of chronic labyrinthitis. Chronic otitis media is progressive as long as it is present. The tendency for spontaneous healing is but little marked when the bony walls of the ear are affected. This is not true of labyrinthitis, which has a great tendency to heal spontaneously even when tuberculosis in other organs is present. Consequently chronic labyrinthitis does not call for surgical treatment. Since acute labyrinthitis is also not a surgical condition, it may be said in general that chronic as well as acute labyrinthitis *per se* is not surgical.

It is a matter of personal choice whether to operate on a diseased labyrinth, but there is no question as to the necessity of a labyrinth operation when the labyrinthitis is complicated. The signs for such developing complications are: fever, changes in the eyegrounds and changes in the blood count and in the results of spinal puncture. In such cases a thorough labyrinthine operation must be performed, the approach being from the posterior fossa.

In Dr. Pollock's first case the labyrinthine operation was indicated because the patient had an elevation of temperature. Whether such an operation should be performed in the second case cannot be answered positively, but the operation would seem to me to be indicated.

#### Unusual Roentgen Studies. DR. J. H. GILMORE.

Roentgenographic studies of the following unusual cranial conditions are shown, obtained from 3,580 examinations of the sinuses and 1,671 examinations of the mastoid at the Illinois Eye and Ear Infirmary since July 1, 1933:

CASE 1.—Mucocoele of an eccentrically lateral-lying frontoethmoid cell which had eroded into the orbit.

CASE 2.—Large osteoma occupying the entire left anterior ethmoid region.

CASE 3.—Large osteoma of the antrum completely filling the sinus and involving the superior maxilla.

CASE 4.—Rhinolith forming a complete cast over one inferior turbinate bone.

CASE 5.—A giant cell tumor of the mastoid process, demonstrating by roentgenographic appearance the difference between neoplastic and inflammatory bone destruction.

CASE 6.—A large cholesteatoma of the mastoid process, demonstrating the value of Towne's position as an aid in such diagnoses.

CASE 7.—Suppuration of the petrous apex observed with the patient in the Taylor position, with subsequent examination demonstrating sclerotic reparation.

CASE 8.—Syphilitic osteomyelitis of the skull on a congenital basis in a woman aged 24, demonstrating two years after treatment almost complete repair of damage.

#### Experiences with Endaural Complete Mastoidectomy and Atticomastoidectomy. DR. ROBERT HENNER.

The purpose of this report is to discuss some experiences since April 1939, during which time 39 endaural procedures were performed. Of these there were

16 simple, or complete, mastoidectomies; 2 modified radical mastoidectomies, or atticomastoidectomies; 20 radical mastoidectomies, or mastoidotympanectomies, and 1 fenestration operation for otosclerosis.

The stages and procedures involved in the operations are discussed briefly.

Sixteen simple, or complete, endaural mastoidectomies were performed. The ages of the patients ranged from 3 to 60 years. Their average postoperative stay in the hospital was eleven and one-half days. There were 4 cases of subperiosteal abscess, 4 of tip abscess, 2 of extensive retrosinus necrosis and 1 of extradural abscess in the zygomatic area. In this case the patient, a boy aged 8 years, had marked zygomatic swelling, a temperature of 104 F. and toxemia. During the mastoidectomy, on exposure of the zygomatic cells, about a half-ounce (15 cc.) of yellow, creamy pus gushed forth under pressure. Dural granulations were exposed and cleaned, and because the squamosal portion of the temporal bone about this area appeared necrotic a portion of bone 5.5 cm. in diameter was removed. This patient had an uneventful postoperative course and left the hospital on the thirteenth postoperative day. Two patients with perisinal abscess associated with granulations on the sinus were operated on. No instances of lateral sinus thrombosis were encountered. However, in 1 routine simple mastoidectomy, the lateral sinus was accidentally perforated while the sinus plate was being skeletonized. The hemorrhage was controlled with a small pack, and the operation was completed through the endaural window without difficulty. The postoperative course was uneventful, and the temperature never rose over 98.8 F. In 1 patient, aged 60 years, bronchopneumonia developed on the eighth postoperative day. This was followed by an erysipeloid infection about the ear on which operation had been done; that condition responded to treatment with sulfanilamide, and the patient was discharged on the thirty-third postoperative day. In 1 case of postauricular fistula, a revision of the mastoidectomy was performed endaurally and the sinus tract everted, but the primary suture of the fistula sloughed; however, it did heal by secondary intention. In another case, within two days postoperatively edema developed over the zygoma. This subsided, but immediately granulations began to spring up in the external canal, and at present the entire canal is stenosing. This occurred as a result of accidental perforation of the posterior membranous canal. In this case it is about five weeks since operation. A plastic operation will be done on the canal at a subsequent date. The condition in the remainder of the cases was the usual coalescent mastoids.

As for the external ear after the endaural complete mastoidectomy, the results are satisfactory. Occasionally when healing has been slow a small antauricular scar may be observed. There have been no cases of perichondritis, collapse of the canal or stenosis, other than the case cited. The endaural approach in the complete mastoidectomy can be performed by an experienced operator, so that every type of pathologic condition of the mastoid can be dealt with adequately. Further, this approach preserves the principle of wide open drainage and permits daily inspection of the mastoid cavity. Since healing occurs from the bottom out, there is no necessity for constant probing to the antrum, and there is no sealing off of a traumatic infection. The postoperative course of these patients has been free of any serious morbidity. Another point to consider is that delayed healing and retroauricular fistula offer no problem, as they do in cases in which the postauricular operation is used. Furthermore, since the attachments of the sternocleidomastoid muscle are uninjured there is little postoperative pain in the neck. The differential diagnosis of meningitis is therefore easier. The only practical difficulty encountered has been that in a few of the cases in which the disease was in an early stage, particularly when there was edema of the skin, exposure of the tip was difficult.

Experience thus far with the atticomastoidectomy shows that the endaural operation for the atticomastoidectomy, or modified radical mastoidectomy, is a procedure of great merit.

Observations on the Endaural Mastoidotympanectomy of Lempert. DR.  
GEORGE WOODRUFF.

In the work on this series the attempt has been to do a complete mastoidectomy and to follow Lempert in his removal of all tissue in and about the middle ear which might harbor disease. The results to date are encouraging.

The incisions are more difficult than is the postauricular incision, especially for a novice. The execution demands thorough knowledge of the descriptive details plus a practical knowledge of the structure of the membranous and bony canal walls. Adequate practice on the cadaver is necessary to overcome these difficulties.

With a little practice one is able to work well through the space afforded by the endaural approach. However, it should be emphasized that a good working knowledge of surgical anatomy and practice on the cadaver are even more important than in radical surgical procedure by the usual route.

After the completion of the simple mastoid operation, Lempert's method in his thorough work in and about the middle ear has been followed. This technic is as follows: First the posterior canal wall is lowered to the level of the facial ridge and the ridge is further brought out by thinning the canal wall from both the canal and the mastoid side. The bridge of bone is removed by inserting the perforating burr beneath it and burring gently outward. The external attic wall is taken out and is moved up to the level of the skeletonized dural plate of the middle fossa and forward until it is flush with the sloping anterior wall. The annulus tympanicus is removed anteriorly, inferiorly and posteriorly, and the anterior wall of the middle ear is thinned, the mouth of the tube, the hypotympanum and the region of the stapes and oval window thus being brought into view. The hypotympanic cells are thoroughly broken down until the floor over the jugular bulb is smooth and the promontory well outlined. The processus cochleariformis is fractured and removed and the tensor tympani muscle evulsed, and any cells about the opening of the tube are curetted out. When necessary the floor of the canal is lowered enough to give a good view of the hypotympanum.

No serious complications have been met, and none that could be charged to the technic.

In 17 of these cases the condition had been diagnosed as uncomplicated chronic purulent otitis media. Of the others, in 1 there was diffuse purulent manifest labyrinthitis. The patient was hospitalized for three weeks, and when all active symptoms had subsided the operation was performed. A fistula was found in the horizontal canal. The postoperative recovery was uneventful. Today the ear appears to be dry, but there is considerable narrowing deep in the canal, though an applicator easily passes through it.

In another case the patient had diffuse serous labyrinthitis, the symptoms of which disappeared after rest in bed. An endaural mastoidotympanectomy was performed sixteen days after admission. At operation a fistula was found in the external canal. The convalescence was uneventful except that there was considerable difficulty in keeping the canal from becoming constricted.

In the third case a diagnosis of circumscribed labyrinthitis was made. Recovery was without any untoward incident.

In 2 cases the present condition is unknown. In 2 others operation has been done too recently to warrant judgment of the result. Of the remaining 16 cases, the patients in 11 have dry ears and in 5 varying degrees of discharge. In general the healed cavities are much smaller than those found after the usual radical mastoidectomy, and the epidermis is considerably thinner and seems to have less tendency to desquamate.

In some cases there has been difficulty in controlling the healing process. This is especially true of those in which the after-care was given by some one not experienced in cases in which radical mastoidectomy had been done. In some instances the middle ear seems to have become obliterated, and in a few considerable constriction of the canal has occurred; in 1 or 2 a false membrane has formed across the canal.

No special claims are made for this operation or for the results. The presentation is given as an example of the results obtained after a fairly good trial of the Lempert endaural mastoidotomy.

One of the advantages is that a better view of the middle ear is afforded than is obtained in the usual operation. However, the postauricular radical operation can be modified to give approximately the same view. The canal incisions are included in the initial incisions and afford a good view of the middle ear and canal region throughout the whole operation. Another merit is that there is no plastic work to be done on the canal, and no sutures are necessary at the end of the operation. Furthermore, these patients have less postoperative pain. They can usually be out of bed earlier and are able to leave the hospital one or two days sooner. The soft tissue covering of the postauricular area is not weakened, and there is little likelihood of retroauricular fistula.

The disadvantages are the difficulty of the incisions and the necessity of working in a smaller field.

Whether to adopt the endaural route for mastoidotomy must be decided by the individual operator. A surgeon who is not willing to perfect himself in the method by work on the cadaver should probably continue with the postauricular route.

Perhaps the most valuable by-product of Dr. Lempert's work in the perfection of his various endaural procedures, especially, of course, the fenestration operation, is the reawakening of interest in otologic surgery. He has done more to stimulate knowledge of the surgical anatomy of the temporal bone than any one has done for decades.

#### DISCUSSION

DR. GEORGE E. SHAMBAUGH JR.: I have used the endaural approach for all radical mastoidectomies and for some simple ones for a year. For the simple mastoidectomy I am not sure the advantages are great. For radical mastoidectomy I think eventually the endaural will replace the postauricular approach. Operation is done via a route where the cavity has to be kept cleaned, and that means that it will be accessible for future care. It is important that the incision be kept wide open until epithelization is complete. After the postauricular operation I have had perichondritis of the auricle develop in 2 cases. I think the endaural approach will obviate this complication, since the incisions are entirely extracartilaginous.

DR. THOMAS C. GALLOWAY: For about a year and a half this operation has been used rather frequently at Cook County Hospital. My conclusions are much the same as those Dr. Shambaugh has given. One can do a simple mastoidectomy endaurally, but in the presence of suppuration of a lateral sinus or occasionally a subperiosteal abscess it is sometimes more difficult to reach all areas of disease. I feel rather sure that the occasional operator performing simple mastoidectomy will do better if he uses the classic approach.

I think the presentations of Drs. Henner and Woodruff deserve a great deal of credit, because these demonstrations lead to much more refinement in technic and anatomy.

For a modified radical mastoidectomy one can hardly imagine a finer technic than this operation offers. As this technic is developed more operations are going to be done without sacrificing the contents of the middle ear. However, there are difficulties. In the first series of cases, because the incision was not carried high enough and a good exposure was not obtained, some stenoses of the canal resulted. Now they rarely occur.

DR. JOSEPH BECK: Some of the men present have used the electrotrephine burr; Dr. Boettcher, who is one of the pioneers, employed it for mastoid operations. That instrument is now being used, and in teaching the use of it one should teach as well the structure of the temporal bone. Dr. Lempert has been working on this method for many years, and numbers of men throughout the country have followed him. The possible complications will be discussed a little later. Dr.



Shambaugh brought out an important point about perichondritis. If there is no difficulty with the cartilage in the postauricular operation, I should say that in cases of acute infection of the mastoid there would be more difficulty in operation by the endaural route. In the cartilaginous part of the canal and the presence of a very virulent infection I think the chances are greater for infection in the neck than with the incision made by the retroauricular method. What this operation will bring when used in cases of acute mastoiditis is still to be seen.

For the semiradical operation that Dr. Henner reported I think that the endaural approach is excellent and that it will give better results and permit better after-treatment than the old method. Why should there be a difference in this operation in the formation of epithelial debris, for the cavity will become lined with some type of modified epithelium as in the radical operation done by the postauricular approach?

An important subject not dwelt on by the discussers is the eustachian tube. I have observed some cases in which operation was done by this method, and there is a better approach to the tubal cells as well as a subsequent closing off of the eustachian orifice. I can cite no case in my experience of radical mastoidectomy in which an occasional cleaning out of the debris which forms in the cavity is not necessary. If this method will reduce that debris to the point where there is a smaller cavity or a reformation of bone, and if some of the patients in these cases come to the autopsy table for another reason than an aural condition, the temporal bone will be found healed. I am looking for such proof of what the Lempert operation will do.

DR. SAMUEL SALINGER: I wish I could share the enthusiasm of Drs. Henner and Woodruff with regard to the use of the endaural method, even admitting a number of points in which the endaural approach is superior to the retroauricular. When I think of the history of endaural mastoid surgery (it goes back to 1875) and consider the vicissitudes through which it has passed and the critical examination to which, having been tried and then generally abandoned, it has been subjected in all European centers, I cannot help but feel that it has been taken up on this side with perhaps too much enthusiasm. Babbitt in Nelson's *Loose-Leaf Surgery* gave an excellent résumé of the history of this procedure. It would be instructive to those who contemplate adopting this operation to read the reports of Thies, who recorded 1,500 cases of endaural operation, with only 1 failure and 1 fatality. Yet although it was taken up by Van Eiken, he admitted later that he had to give it up. Other men tried various modifications of this approach, and most of them finally abandoned it in favor of the retroauricular one, particularly in cases of acute infection. There is one thing I cannot understand in the technic of the endaural radical mastoidectomy. When a postauricular radical mastoid operation is done, particular care is taken to preserve the membranous canal for the plastic procedure. In the operation under discussion a great deal of this same tissue is removed and discarded, the dehiscence then filling in with scar tissue. I admire the enthusiasm of Dr. Henner and Dr. Woodruff and believe that their report will stimulate interest in the technic as well as a more intimate knowledge of the detailed structure of the middle ear. However, if they mean to convey the impression that the endaural approach should supplant the retroauricular approach, I should take issue with them, particularly in relation to the cases of acute infection. One of them mentioned that when operation is done by the endaural approach the cavity epithelizes from the bottom up. This is a distinct disadvantage as compared with the retroauricular operation, in which the drainage is naturally at the most advantageous point, namely, the lower end. On the other hand, if the endaural approach is employed in the case of a sclerotic mastoid process, in which there are no mastoid cells and in which the object is to clean out the mastoid antrum and the middle ear, I can see that this method will save the patient a great deal of pain and discomfort.

DR. M. A. GLATT: It has been stated that the endaural approach is suitable for the radical mastoid operation but that it has no advantage over the postauricular approach.

I have performed all my radical mastoidectomies by using Stake's method of approach, that is, by taking down the posterior canal wall at a sufficient depth, which easily exposes the mastoid antrum. A small cavity, which does not require long postoperative care and leaves no postauricular depression, is thus obtained.

The endaural approach may produce much cleaner cavities because a large portion of the membranous canal that has hairs and ceruminous glands is discarded, desquamation which would otherwise take place thus being eliminated. The epidermis that covers the new cavity is better nourished because it advances over a thick layer of granulation tissue. This feature can be easily duplicated by the postauricular approach. To become proficient with the endaural method requires many hours of training in the use of a dental drill and the various sizes of burrs. The smaller the burr the more dangerous it is. In the endaural method one works mostly with small burrs. It is therefore difficult to introduce it as a routine method to the intern staff.

I can see the advantage of the endaural approach as a step forward in the surgical treatment of otosclerosis or petrositis, and as such it is to be encouraged.

DR. GEORGE WOODRUFF: Dr. Shambaugh and Dr. Galloway appear to hold substantially the same opinions that we do on the operations under discussion.

This presentation of cases has been made to give an idea of the results we have obtained using the endaural approach. We are not attempting to say that these methods should be universally adopted. At present we are more favorably impressed with the endaural route for mastoidotympanectomy and atticomastoidectomy than for complete mastoidectomy. Our results of mastoidotympanectomy since adopting this technic are undoubtedly greatly improved. However, we intend to go on doing all mastoid operations in our service through the endaural route at least until April 1, 1940, which will make more than one year during which all surgical procedures on the mastoid, with the exception of those performed in 2 cases, have been done by the endaural route. I believe that Dr. Henner and I both hold the opinion that the advantages of endaural mastoidotympanectomy and endaural atticomastoidectomy definitely outweigh the disadvantages. Concerning complete mastoidectomy we prefer to reserve our judgment until we have had more experience. We have found it somewhat more difficult to perform some of the steps of the complete mastoidectomy through the endaural route than through the postauricular route.

In this series of cases there has been no perichondritis. The after-care is of course important. The dressings should be done with the usual sterile surgical technic. After the first four or five days, dressings and bandages are left off and the patient wears only a pledget of sterile cotton in the meatus. He is instructed to change the cotton every hour and always to throw away the first piece and put the second one in the meatus. Because of this rather meager dressing, it seems that infection of the edges of the wound might easily occur. However, unless 1 instance of erysipelas can be ascribed to this source, we have had no such trouble.

Dr. Beck mentioned that in 1 of our patients whom he examined the eustachian tube was definitely closed. I do not know in how many we have obtained this result, but I believe that if the Lempert technic is thoroughly followed the tube will close in a high percentage of cases.

Dr. Salinger talked about the history of the operation. We know that some mastoid surgical procedure was done many years ago by several different men through an endaural route. Just what technic they used and how extensive the work was in the temporal bone I am not prepared to say. I feel sure, however, that the operation on the temporal bone was of quite a different type than that done by Dr. Lempert. Of course, the finely controlled dental burr and modern curets are a great improvement over the more clumsy instruments of an earlier period.

Dr. Glatt mentioned the point that in the radical operation by the Lempert technic a fair-sized piece of skin is discarded. In 1 of our cases, by slight modification of the incisions, this skin was saved. This can be done easily, but on the basis of our experience to date we question the advantage.

It was mentioned that the cavities in our cases in which mastoidotympanectomy was done are smaller than those seen after the usual operation. We do a thorough exenteration of the mastoid process and have a large cavity when we stop the operation. Instead of trying to maintain a cavity of that size we allow the mastoidectomy cavity to granulate in to a large extent and then become epithelized. Therefore we do not have large cavities. We are not always able to control this healing process as we should like, but for the most part we are pleased with the results.

Epithelization takes place from the edges of the canal skin. The new epithelium seems to be of a different type from that seen after many radical operations in which flaps are turned in. It appears to be thinner and apparently has less tendency to desquamate. Of course the smaller cavity is of some advantage, in affording less chance for desquamation and collection of the resulting debris.

Dr. Boettcher, who was one of the first physicians, at least in this area, to use the burr, brought up the question of instruction in the use of the burr. I agree the residents should have instruction and experience in the use of the burr before using it in operations, though I do not feel that it is a hard instrument to use. Our residents have an opportunity to obtain some of this experience on the cadaver, thus combining their experience in the use of the burr with practice in the actual procedures which they will be called on to perform.

The exposure of various areas of the mastoid cavity is facilitated by two maneuvers. Dr. Lempert emphasizes the point that the endaural window is mobile and can be shifted about to different points over the mastoid area. I have been able to do this to some extent, but I want to mention that turning the patient's head is also a great aid in reaching the various areas to be dissected. A good assistant holding the retractors properly has almost complete control of the head, and by shifting the window and turning the head he can greatly facilitate the operation.

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GEORGE T. JORDAN, M.D., *President*

WALTER H. THEOBALD, M.D., *Secretary*

*Regular Monthly Meeting, Jan. 8, 1940*

#### Laryngocele Ventricularis. DR. J. R. LINDSAY.

Superior external laryngocele occurred in a woman aged 38. The swelling in the neck came on during coughing two months prior to the first examination. There was no pain at first, but the swelling increased steadily until it was about the size of a large hen's egg and then gave discomfort when distended. Reduction could be easily produced by pressure and was accompanied by the sound of escaping air in the throat. Some fluid was present in the sac also, and purulent material was expressed into the throat. The interior of the larynx was normal on examination, both when the laryngocele was distended and when it was collapsed. There was no hoarseness or dyspnea.

The laryngocele was completely removed by external operation, and one year had elapsed with no sign of recurrence.

The etiology of ventricular laryngocele in man is discussed. The exciting cause has apparently been variable; for example, coughing, blowing wind instruments, glass blowing and loud shouting have given rise to the condition. It has occurred in children. It is evident, however, that the important factor in all cases has been an increased intralaryngeal pressure, transmitted via the ventricle to the appendix or saccus, with consequent herniation.

The existence of a predisposing factor, namely, an abnormal development of the appendix, seems probable in view of the relative frequency of the condition in children and women, who would appear to have been less subjected to muscular strain.

Roentgenograms taken by means of the planograph are demonstrated to show the action of the glottis and thereby to explain how increased pressures within the thorax are transmitted to the ventricle of the larynx. The following facts are demonstrated:

1. During physical exertion of the upper extremities, straining or bearing down, the glottis is firmly closed by narrowing at its upper aperture (above the ventricles), as well as by approximation of the true cords. The trachea is dilated, indicating increased intratracheal pressure. The closure provided by the true cords is less capable of resisting pressure from below, and the intratracheal pressure is transmitted to the ventricles.

2. During inspiration the glottis can be closed more efficiently by the true cords, since there is an additional valvular action when the cords come together.

3. The shape of the false cords, as shown by the planograph, precludes any valvular action on their part either on inspiration or on expiration. Closure of the glottis is maintained by muscular action.

During coughing increased intratracheal pressure is utilized, with the upper aperture of the glottis closed during the initial stage. Similarly, during certain types of forced shouting the glottis is closed in the initial stage, thereby providing the increased intralaryngeal pressure. Dilatation of the laryngocele in the reported case was demonstrated under such circumstances.

#### DISCUSSION

DR. FREDERIC E. TEMPLETON: Tomograph, laminograph and planograph are names applied to instruments which by means of roentgen rays project planes of the subjects being examined onto films, obliterating planes above and below by relative motion. The superiority of such roentgenograms to stereoscopic ones of good quality in determining the location and exact nature of certain structures is yet to be proved. One of the best examples of their use is in examination of the anteroposterior projection of the larynx, in which the dense shadow of the cervical portion of the spine is obliterated.

A simple adaptor for my regular roentgenologic table was devised at little cost. A description of the apparatus follows: A metal plate is bolted or fixed with wing nuts in an upright position to the side of the table. The plate contains a slot or a series of holes 1 cm. apart, which runs in a longitudinal direction through the plate at right angles to the table top. A bolt which swivels on a metal block is passed through the groove or one of the holes and is fixed in position by a wing nut on the medial side. The swiveled metal block, fixed on the lateral side or outside of the metal plate, contains a smooth hole, through which runs a rigid rod. This part of the apparatus is known as the fulcrum. The lower end of this connecting rod runs through a slot in another swiveled block which is fixed to a Potter-Bucky grid at the same height and in a direct line to the transverse center of the film as it lies in a Potter-Bucky grid tray. The upper end of the rod is firmly fixed to the tube; any movement of the apparatus keeps the central ray of the tube directed along a plane which runs through the rod. In this way, with the tube over the exact center of the film, with the rod in an exact vertical position and with the fulcrum firmly fixed to the edge of the table, the center of the beam is always directed on the center of the film. The drive is furnished by pulling a cord attached to any of the movable parts, preferably the tube carriage, which moves a short distance along its supports when the apparatus is in motion.

An automatic drive can be devised with additional expense. A strong string can be fixed to the movable tube carriage at one end and anchored to some fixed part at the other end. The carriage is then "cocked" by being moved so that the spring is on a stretch. It is held in position by a magnetic release, which is electrically wired in, parallel with the grid release magnet. An oil chamber, attached to the carriage, will give smooth, even movement in addition to allowing an accurate control of the speed.

In the use of such a machine, the level of the plane desired is obtained by moving the fulcrum up and down to the desired height above the table surface. It must be remembered that all criteria for good images which apply to the making of ordinary roentgenograms apply to this instrument. In addition, other factors enter. Two of these are the absence of any play in the movable joints and the rigidity of the connecting rod. If any play is present, the effect will be the same as when a tube is violently shaken while ordinary roentgenograms are being made.

I do not claim that the results obtained with such an instrument will equal those of any of the commercial machines, but if properly constructed it will give satisfactory service.

DR. JOSEPH C. BECK: Some years ago a small group of physicians used to meet each month to talk over our troubles and failures. At one of these informal meetings Dr. Freer was present when Dr. Shambaugh told of a case of prolapse of the laryngeal ventricle in which he was going to operate. The patient had a tumor which appeared on the side of her neck whenever she gave singing lessons. Dr. Freer objected strenuously to the operation, from the standpoint that the procedure Dr. Shambaugh and Dr. Lewis had planned would ruin the patient's "economic voice," an essential physiologic structure for this woman, who had become accustomed to using her voice in the presence of the prolapse. The operation was performed and was reported several months later as being successful. Some time later, at a joint meeting with the Surgical Society, this case was again reported by Dr. Freer, but the operation, he said, was not successful because the scar gave way and the prolapse recurred.

I was much interested in Dr. Lindsay's roentgenologic demonstration. It seems to me that if it is to be complete, and especially as it refers to the work of Negus, it should be supplemented by moving pictures of roentgenograms. I have seen recently a wonderful picture showing the roentgenograms of a person chewing, as photographed from a fluoroscope.

### Vertebral Caries in Infections of the Retropharyngeal Space. DR. G. H. SCOTT.

The retropharyngeal space lies posterior to the pharyngeal musculature and is limited anteriorly by the deep cervical fascia and posteriorly by the prevertebral fascia. Medially it is divided into right and left compartments by the median raphe. Laterally, it is separated from the pharyngomaxillary space by the thin ala fascia.

Pus in this area usually remains localized to the pharyngeal region but may descend along the fascial planes overlying the longus colli and scalenus muscles to present as an abscess in the posterior triangle or even in the axilla. In some instances the infection follows downward into the posterior mediastinum.

Retropharyngeal abscess may be acute or chronic. Vertebral caries is more commonly seen as the cause than as the result of chronic retropharyngeal abscess.

In the acute form of the disease palpation of the pharynx or even depression of the tongue may produce an alarming interruption of respiration or cause death. Lateral roentgen examination of the neck is a safe and reliable diagnostic method. It at once reveals the extent of the soft tissue abscess, as evidenced by an increase in the width of the retropharyngeal space. At the same time it reveals vertebral caries should such a condition exist.

The cases presented and the conditions which they demonstrate clearly are as follows:

CASE 1.—The anomaly was an acute retropharyngeal abscess occupying almost the entire cervical region. Depression of the tongue produced alarming respiratory difficulty. The abscess was drained externally, with the region under local anesthesia. General anesthesia would have increased the hazard. Although good drainage was established externally, the retropharyngeal swelling did not subside entirely. This necessitated incision of the abscess by the oral route as well. Pus under great pressure shot out of the mouth when the incision was made.

CASE 2.—In this case there was a chronic retropharyngeal abscess of three months' duration. It was incised through the mouth and straw-colored fluid obtained. The Wassermann and Kahn reactions were strongly positive. Diagnosis of pharyngeal gumma was made.

CASE 3.—The condition in this instance was a chronic retropharyngeal abscess of three months' duration, which had been mistaken for a cyst and had been injected with iodized oil six weeks before the patient had come to the clinic. As shown by roentgenograms, the iodized oil descended to the posterior mediastinum but the abscess remained localized in the retropharyngeal space. The abscess was incised intraorally, but it recurred and subsided only after diseased tonsils were removed.

CASES 4, 5 and 6.—Case 4 was one of chronic retropharyngeal abscess unrecognized for several months, as evidenced by roentgenograms which had been taken four and one-half months before the patient's admission to the clinic. The pus had presented bilaterally in the posterior cervical triangles. A roentgenogram made on admission showed early erosion of the cervical vertebrae without destruction of the intervertebral disks. This is in sharp contrast to case 5, which is a case of cervical Pott's disease with retropharyngeal abscess. In this instance the collapse of the intervertebral disk is an outstanding feature. The destruction of the intervertebral disks is even better shown in case 6, also one of cervical Pott's disease.

The erosion of the vertebrae continued in case 4 even though through and through drainage was established in the neck. A posterior mediastinitis developed and was drained through the back. The patient died of pulmonary embolus. All tests, including guinea pig inoculation, failed to reveal any evidence of tuberculosis. This case is obviously one of vertebral caries secondary to a nonspecific infection of the retropharyngeal space.

#### DISCUSSION

DR. ARTHUR PROETZ: I do not know when I have encountered such an instructive series of cases as those just presented or such an instructive series of roentgenograms. It occurred to me while Dr. Scott was talking that it would be extremely useful in interpreting the advancement of these infections and the behavior of some of these swellings if differentiation were made between the retropharyngeal and the prevertebral spaces, as should be done. As a matter of fact, in the textbooks anatomists almost never do so, or if they do, it is merely in passing. However, the spaces are quite distinct. The fascia which separates them is thin and tough. The retropharyngeal space stops at the carotid sheath, whereas the prevertebral space spreads around to the side and ends where the nerve roots emerge, and this may have something to do with occipital headaches and rigidity of cervical muscles. The longus colli and longus capitis muscles lie within this space, and the roots of the brachial plexus are in contact with it. The muscle attachments to the skull and the atlas, respectively, constitute the upper delimitation, and the lower is the upper margin of the mediastinum. The case Dr. Scott mentioned in which he opened the abscess through the neck externally and found after a day or so that the drainage was not sufficient indicates that the retropharyngeal space was drained and the prevertebral perhaps only buttonholed. When the abscess was opened through the pharynx the space was reached and proper drainage accomplished.

The roentgenogram of the patient in whom iodized oil was injected shows this space beautifully. The iodized oil lay close against the vertebral column and did not fill the whole abscess cavity. The tough membrane is often the thing that prevents the abscess from draining and is the determining point between drainage and extension. I have seen in 1 case at autopsy infection of the diaphragm space through perforation of the mastoid tip. The infection invaded the prevertebral space, broke down the attachment at the midline, went up on the other side through the foramen magnum near the vertebral artery, formed an abscess there and killed the patient.

The existence of these two spaces is not theoretic. If the cadaver is sagittally sectioned a little to one side of the midline and a stream of compressed air is allowed to play over the sectioned surfaces for a few moments, the spaces lay themselves open and show definitely how infection may appear in one space without invading the other.

DR. G. H. SCOTT: I wish to thank Dr. Proetz for his intelligent discussion of this subject. His distinction of the prevertebral and retropharyngeal fascial spaces offers an explanation as to why the injected iodized oil descended into the thorax while the pus lying anterior to it in the retropharyngeal space remained localized in the pharyngeal region.

#### Eustachian Tube: Abnormal Patency and Normal Function. DR. H. B. PERLMAN.

While much treatment is directed to the eustachian tube, knowledge of its functions and methods for determining them have been remarkably static for the last half-century.

One can learn a great deal about the function of the eustachian tube by studying the patients with the syndrome usually referred to as the continually open eustachian tube. A moving picture is shown of a thin, atrophic drum moving synchronously with respiration in a patient with an open eustachian tube. A valuable adjunct in studying cases of this syndrome as well as those of other otologic conditions involving the eustachian tube is the use of a simple quantitative method for studying patency of the eustachian tube. This technic entails chiefly the employment of the ordinary wall manometer of a blood pressure apparatus. Definite minimal pressures for inflating the normal tube by Valsalva's maneuver are established for this method. A great decrease in this pressure was found in the group of patients with the open eustachian tube when the tube was temporarily closed and the patient free of symptoms. It was found that the reclining position greatly increased the resistance of the tube in the normal subjects as well as in those with the open eustachian tube and in patients with suppurative ears, so that the highest pressures that the patient could produce were inadequate to open the tube. Exercising decreases the resistance of the tube in normal persons and in those with suppurative ears. Abnormal patency of the eustachian tube was found in subjects who had involvement of the fifth motor nerve following a retrogasserian neurectomy. New experimental equipment used to study the function of the eustachian tube and the records obtained are briefly described and illustrated by lantern slides.

In conclusion, a moving picture is shown of movement of the eustachian cushion in the human being, taken through a large defect in the hard palate when the subject was forming the sound "ah" and when he was swallowing.

#### Cranial and Intracranial Complications of Acute Frontal Sinusitis. DR. PAUL C. BUCY and DR. W. TRACY HAVERFIELD.

Three cases of acute frontal sinusitis which developed immediately after swimming are presented. In the first an extensive osteomyelitis of the right frontal bone and an abscess of the right frontal lobe occurred. The patient was admitted to the hospital two and one-half months after the onset, in a semicomatose state. Drainage of the abscess and removal of the osteomyelitis in three stages resulted in recovery, though vision was rather seriously impaired. In the second case the right frontal sinusitis appearing immediately after swimming was soon complicated by an osteomyelitis which was quickly relieved by extensive extirpation one month after the swimming. There were no intracranial complications. In the third case it was a *left* frontal sinusitis that appeared after swimming. Though no osteomyelitis developed, an abscess of the *right* frontal lobe soon appeared. This patient recovered after drainage of the abscess about three months after the swimming.

A fourth case is presented, in which a localized osteomyelitis along the course of the *left* anterior temporal diploic vein developed after an abscess beneath the



left temporal muscle. Shortly thereafter an abscess developed in the *right* cerebral hemisphere beneath the central region.

These cases being used as a basis for discussion, it is pointed out that:

1. Extension of the infection from the sinus is usually via the frontal and the anterior temporal diploic vein to the frontal bone, thence intracranially through small emissary connections into the superior sagittal sinus and down one of the connecting veins into the cerebral hemisphere of the same or the opposite side.

2. Prophylactic measures must be directed toward prevention of the sinusitis itself as well as of spread of the infection beyond the sinus.

(a) Development of sinusitis as a result of swimming can be in some measure prevented by (1) proper breathing, (2) proper diving, (3) use of nose clips and (4) avoidance of chilling. (b) Avoidance of spread of the infection from the sinus once a sinusitis has developed may be attained by prompt, adequate, external drainage of the sinus in those patients in whom local pain, tenderness and swelling over the sinus, associated with fever, develop after swimming.

3. All acute osteomyelitis of the skull should be treated by wide excision of the infected bone as soon as the diagnosis is made. It is not possible to rely on the roentgenograms for diagnosis if prompt treatment is to be instituted, as they do not show change until ten or twenty days after the onset of the infection of the bone. The diagnostic sign of the development of this complication is edema of the forehead spreading upward from the sinus.

4. Abscess of the brain should be treated by prompt aspiration and drainage, with careful attention to the protection of the meningeal spaces from infection by obliterating them about the field and not operating through an infected field.

5. The bony defect resulting from extirpation of the osteomyelitic bone is usually spontaneously repaired by regeneration of bone.

#### DISCUSSION

DR. THOMAS GALLOWAY: Dr. Bucy gave an illuminating discussion, especially as to the distribution of the diploic veins. One assumes that in most of the patients with abscess of the brain whom Dr. Bucy has had the conditions are more chronic than the ones seen in otolaryngologic practice, an assumption which raises the question as to the time of operation for such an abscess. Should one wait for localization? I now have a patient, a boy presenting a history of a cold twelve days before, who entered the hospital with a perforating frontal sinusitis. A simple drainage was done at the external angle and at the internal angle with trephine of the sinus and considerable pus obtained under pressure. In three days he had a crossed weakness of the arm and a crossed paralysis of the facial nerve. His general condition was good. A Killian operation was done in order to expose the dura, and that membrane was glistening and smooth. Eight days after the apparent onset of frontal sinusitis the first localizing symptoms really suggesting intracranial complications were seen. Today the patient is sluggish mentally and does not answer questions well. There are 106 cells in the spinal fluid. What would Dr. Bucy do in such a case? As to frontal sinusitis, I think most rhinologists believe that early operation, if it cannot be avoided, should be restricted as much as possible, and I think I encounter more cases in which complications develop from early operation than cases in which complications are prevented by early operation. I have tried to avoid intervention during the first seven days if it is possible.

DR. T. E. WALSH: I should like to emphasize what Dr. Bucy said about intervention in these conditions when they become chronic, that is, when chronic frontal sinusitis is associated with osteomyelitic changes in the bone. I recently have had as a patient a man with roentgen evidence of thickening of the bone of the periphery of the sinus and with definite evidence of clouding of the frontal sinus. A radical frontal operation was done, and the bone was found to be only slightly roughened along the lateral margins of the supraorbital ridges. I made the mistake of not operating radically enough. Osteomyelitis developed, and I have had to remove most of the cranial vault. The patient is alive; I do not



know why. When operation is performed on a patient whose condition is suggestive of osteomyelitis, it is worth while to do a radical removal of a bone in the first operation. In general I am against radical surgical treatment, but I think in such cases it is essential. I agree with Dr. Galloway that "hands off" for the first few days of an acute frontal sinusitis is best. I find that if one intervenes surgically in acute frontal sinusitis more trouble is apt to result than if conservative treatment is used.

DR. FRANCIS LEDERER: Some one else might have given this same presentation from a different angle and reversed the order in which the patients came to the specialist. Conservatism in the early days seems to have been the usual attitude from a rhinologic standpoint. Many of the cases discussed by Dr. Bucy have been presented to illustrate the result of too early surgical intervention. How does one know when to intervene in cases of this kind? One can find in one's own practice and in the literature just as many instances in which it can be said that complications such as abscess of the brain are due to early intervention as those in Dr. Bucy's series in which such complications can be ascribed to late intervention. It is essential to distinguish two kinds of osteomyelitis: a virulent, fulminating type (rapid, or acute) and the type with which Dr. Bucy was mainly concerned (chronic, or slow). To my mind, therefore, they offered the positive good results which he obtained. I can well imagine intervening surgically in those conditions on the appearance of the puffy swelling, having the same complication occur and attributing it to too early intervention. I still do not believe that the treatment of these lesions can be stereotyped and that it can be said positively that in all instances operation must be done early or that early intervention will prevent this intracranial picture. I think judgment should be based on the virulence or the chronicity of the condition. Further, I believe that most rhinologists agree that they do not like to incise an area of spreading osteomyelitis too early. Clinical signs and roentgenologic investigation give no absolute index as to the microscopic spread of the process. One can well understand that the process is constantly advancing one step ahead of the scalpel. When the condition has existed for weeks or months before the patient comes to operation, there is an excellent opportunity to remove osteomyelitic bone and achieve the same results Dr. Bucy did. On the other hand, when the osteomyelitis is acute and just one step ahead of the scalpel, the operator feels that the possible outcome is not quite so certain as one would be given to believe by his excellent results. The swimming problem is important and worthy of the emphasis given by Dr. Bucy. My associates and I had at one time 3 patients with osteomyelitis that followed swimming. I believe prophylaxis should be emphasized in combating this complication.

DR. JOSEPH C. BECK: Dr. Bucy commented on the loophole that Furstenberg left in his report as to regeneration of bone after cranial operations. I should like to have Dr. Bucy say something about complications, such as epilepsy, following the extensive removal of bone. I am referring to a case of extensive osteomyelitis in a boy the greater part of one side of whose skull was removed. The patient made a splendid recovery, but epilepsy developed. Several months after operation the roentgenogram of the defect was studied and evident regeneration of bone was found, which one could also feel. The neurologic surgeon called in advised the exploration of this region for the cause of epilepsy. When he exposed this area I was delighted to see how much bone had regenerated to cover the defect. He removed some particles of this so-called bone, and I have sections to show there was not one bit of bony structure in what the roentgenogram and palpation showed to be bone. It was dense and calcified tissue, but there was no real bone. Differentiation must be made between these two, and I think it makes a difference as to what cover the brain has afterward. I should like to hear from Dr. Bucy specifically about that. Furstenberg, I believe, called attention to some of his cases in which there were jacksonian symptoms.

DR. PAUL C. BUCY: In reply to the first question, I do not believe that the infection spreads by way of dural vessels. I think it can be seen from these roentgenograms that it is spread by vessels between the two layers of bone

within the diploe. As a matter of fact, there are few vessels in the dura mater. The diploic veins do eventually pass through the dura mater, but I should hardly call them dural vessels.

As to the time of operation for abscess of the brain, this is a point on which I am in disagreement with many neurosurgeons. A year ago I published the results in 17 consecutive cases, with recovery in 70 per cent (Bucy, P. C.: Treatment of Brain Abscess, *Ann. Surg.* 108:961-979, 1938). According to my experience, the time to operate on an abscess of the brain is at the time of diagnosis, and that has been my practice. I have had patients operated on within twelve days after the earliest possibility of infection who made a prompt and complete recovery. That is now common. In most cases the disease is of considerably longer duration before operation, and I think there is undoubtedly a measure of safety in having a longer period elapse. There is no question but that more attractive statistics on operative mortality can be obtained by waiting, as the patients with the more virulent, rapidly progressive infections will then die before coming to operation. That is why McEwen had such excellent results. He was dealing in every case with a chronic, well localized and well encapsulated abscess of the brain. I am sure, however, that many of the patients with the more acute form of the disease can be saved by prompt drainage and that the mortality for all cases of abscess of the brain can be lowered by such treatment, even though the operative mortality is raised.

As to operation on the frontal sinus for drainage, I do not feel competent to say exactly what operative procedure should be followed. You are better judges of that than I. I am inclined to believe that the operation should be as limited as possible and yet achieve adequate drainage. Obviously it is of no advantage if it does not.

I am familiar with Dr. Walsh's case, and I am sure that he should be complimented on "still having the case." The condition has been an extremely difficult one and has been handled well.

As Dr. Lederer has said, roentgenograms similar to these have been shown in the past and the osteomyelitis has been attributed to an operation on the sinus, merely because it followed operation. Frequently that is an incorrect interpretation, for, as has been shown here, such osteomyelitis does develop spontaneously as a result of acute frontal sinusitis which follows swimming. I have always looked on chronic osteomyelitis as of much longer duration than in these instances. In the second case the entire history covered only a month and the osteomyelitis was of two weeks' duration. In the other case the osteomyelitis had been present a little longer and was therefore much more extensive. I agree that there are two types of osteomyelitis, the chronic localizing type and the diffuse spreading type, but I am not able to tell which is going to develop, and it is my feeling that in every instance the osteomyelitis should be widely excised.

With reference to Dr. Beck's discussion, although such complications as epilepsy do occur after osteomyelitis, they are not common, but after abscess of the brain convulsions are an extremely common as well as an unfortunate and disagreeable complication. Undoubtedly in such cases the convulsions are related to the scar formation which follows drainage of the abscess. It would therefore appear logical to treat such convulsions by removing the scar, as one does in traumatic cases. Unfortunately infection often follows an attempt to take out the scar. The scar harbors infection for months and years after all evidence of infection has disappeared. The same organisms have been recovered from the scar tissue years after the abscess has been successfully treated. Attempts to remove the scar have resulted in meningitis, and I think attempts to remove such scars have been discontinued. The convulsions which follow osteomyelitis alone are more difficult to understand. I have observed 1 case in which the subdural space was obliterated; the dura mater and the pia-arachnoid were adherent to the surface of the brain, and I feel sure that that was the cause of the convulsions. As to regeneration of bone, undoubtedly there are cases in which only calcification develops, but I am sure Dr. Beck has encountered many cases, as I have, in which there has been a replacement of bone itself.

## Book Reviews

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**The Displacement Method of Sinus Diagnosis and Treatment.** By Arthur W. Proetz, M.D., Professor of Clinical Otolaryngology, Washington University School of Medicine, St. Louis. Second edition. Price, \$6.00. Pp. 296. St. Louis: Annals Publishing Company, 1939.

Though the method described in the first edition has not been changed, the second edition of Dr. Proetz's monograph has brought certain details up to date, necessitating a thorough revision as well as a complete resetting of type. The literature, both of the United States and of foreign countries, is reviewed; many comments and controversial matters are discussed, and twelve new illustrations have been added.

The volume now contains a bibliography of 226 references, and 32 pages are devoted to a review of the literature. There are 296 pages in all, the entire subject matter being covered in twenty chapters.

The author starts with a full discussion of the fundamentals of sinus filling and displacement, the anatomic, physical and physiologic considerations thereof and the pathology and theory of treatment, and then he deals at length with solutions and radiopaques. A complete dissertation on the roentgenologic procedures is presented in several chapters, suitable illustrations augmenting the value of the text. Every means of sinus diagnosis by the displacement method, the varied technics and kindred data concerned in obtaining accurate filling of the sinuses with radiopaque mediums and evaluation of the roentgen studies, these and many more matters are thoroughly covered in designated chapters. Further chapters include those on interpretations, sources of error and observation of allergic changes in the sinuses by means of radiopaque mediums; a number of case records are cited. The entire format, including type and binding, of the monograph is excellent.

The first edition of this work was awarded the Casselberry prize of the American Laryngological Association in 1931, and the present volume likewise represents Dr. Proetz's great contribution to American otolaryngology, for which he deserves the highest praise.

This book is recommended to all physicians, especially the otolaryngologist and the roentgenologist, as well as to graduate students and resident physicians in either of these specialties, and its message is so valuable that it merits the attention and careful study of any reader.

**Argyria, The Pharmacology of Silver.** By William R. Hill, M.D., Instructor in Dermatology and Syphilology, University of Pennsylvania, and Donald M. Pillsbury, M.D., Associate Professor of Dermatology and Syphilology, University of Pennsylvania. Price, \$2.50. Pp. 172. Baltimore: Williams & Wilkins Company, 1939.

The authors have skilfully and accurately brought the clinical entity, argyria, up to the minute in a fairly concise yet complete monograph of 133 pages. Not only is the subject critically reviewed, but a complete bibliographic reference to date is given, covering practically every phase of the subject. It is particularly timely because of the widespread use and application of silver preparations for an increasing assortment of ailments. The importance of proper dosage, compounds in general use, modes of administration, preparations most frequently used, and other such matters are critically investigated, and conclusions are based on scientific evaluation and determinations. The volume is of value to the general practitioner and to the specialist alike, since it not only concerns itself with the detailed clinical aspect of the subject but incorporates perhaps the best chapter written so far on the pharmacophysiologic effects of the administration of silver.

Every effort is made to evaluate precisely conclusions based on theory, conjecture and established fact, recognized value being given to each only when its status and basis are convincingly accurate. Since argyria is permanent and commonly produces unsightly discoloration in exposed parts, it may take on a medicolegal aspect commensurate with the psychologic and social makeup of the person affected. A note of warning is sounded against the unbridled and prolonged use of silver preparations, and the authors feel that pharmacists should give clearly, by label, adequate warning regarding argyria.

The authors deserve congratulations on this valuable book.

**The Diagnosis and Treatment of Diseases of the Esophagus.** By Porter P. Vinson, M.D. Price, \$4. Pp. 224. Springfield, Ill., Charles C. Thomas, Publisher, 1939.

Dr. Porter P. Vinson's book is indeed a much needed and worthy contribution to the present medical literature. The book is subdivided into sixteen chapters. The style is straightforward and clear. The book should be read by many members of the medical profession in general practice, so that they may become better acquainted with the large variety of esophageal lesions and especially with the fact that although malignant growth is always to be suspected, many other conditions may exist which are benign and respond to treatment.

The reviewer has the greatest respect for Dr. Vinson's conservative attitude in regard to the treatment of these conditions, for esophagoscopy is a delicate method and surrounded with danger even in the hands of the best trained physician. On the other hand, the reviewer is not in direct accord with some of Dr. Vinson's ideas, especially on the differential diagnosis of esophageal lesions by blind bougienage. With the perfected instrumentarium at the disposal of physicians today, the direct visualization of conditions thought to be pathologic by the open tube method is invaluable.

Although the entire book reflects the author's wide range of personal experience, he has included at the end of each chapter an excellent bibliography, extremely useful for collateral reading to physicians particularly interested in this field. Dr. Vinson is especially to be commended for his extensive drawings and roentgenographic reproductions. It is hoped that this book will be accorded the warm reception it justly deserves.

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## News and Comment

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**American Congress of Physical Therapy.**—The nineteenth annual scientific and clinical session of the American Congress of Physical Therapy will be held Sept. 2 to 6, 1940, at the Hotel Statler in Cleveland. The mornings will be devoted to an annual instruction and the afternoons and evenings to scientific sessions. There will be symposiums dealing with light, heat and electricity as important therapeutic adjuvants in general medical and surgical practice.

Further information may be procured by writing directly to the Congress, 30 North Michigan Avenue, Chicago.

# Directory of Otolaryngologic Societies \*

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## NATIONAL

### AMERICAN MEDICAL ASSOCIATION, SCIENTIFIC ASSEMBLY, SECTION ON LARYNGOLOGY, OTOTOLOGY AND RHINOLOGY

Chairman: Dr. Leroy A. Schall, 270 Commonwealth Ave., Boston.

Secretary: Dr. Louis H. Clerf, 1530 Locust St., Philadelphia.

Place: Cleveland.

### AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Frank Brawley, 30 N. Michigan Ave., Chicago.

Executive Secretary: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.

Place: Hotel Cleveland, Cleveland. Time: Oct. 6-11, 1940.

### AMERICAN BRONCHO-ESOPHAGOLOGICAL ASSOCIATION

President: Dr. Lyman Richards, 319 Longwood Ave., Boston.

Secretary: Dr. Paul Holinger, 1150 N. State St., Chicago.

Place: Waldorf-Astoria Hotel, New York. Time: June 5, 1940.

### AMERICAN LARYNGOLOGICAL ASSOCIATION

President: Dr. James A. Babbitt, 1912 Spruce St., Philadelphia.

Secretary: Dr. Charles J. Imperatori, 108 E. 38th St., New York.

Place: Westchester Country Club, Rye, N. Y. Time: May 27-29, 1940.

### AMERICAN LARYNGOLOGICAL, RHINOLOGICAL AND OTOTOLOGICAL SOCIETY, INC.

President: Dr. Lee M. Hurd, 39 E. 50th St., New York.

Secretary: Dr. C. Stewart Nash, 708 Medical Arts Bldg., Rochester, N. Y.

Place: Waldorf-Astoria Hotel, New York. Time: June 6-8, 1940.

### SECTIONS:

Eastern.—Chairman: Dr. John R. Simpson, Medical Arts Bldg., Pittsburgh.

Southern.—Chairman: Dr. Walter J. Bristow, Doctors Bldg., Columbia, S. C.

Middle.—Chairman: Dr. Sam E. Roberts, Professional Bldg., Kansas City, Mo.

Western.—Chairman: Dr. Pierre Viole, 1930 Wilshire Blvd., Los Angeles.

### AMERICAN OTOTOLOGICAL SOCIETY

President: Dr. Horace Newhart, 527 Medical Arts Bldg., Minneapolis.

Secretary: Dr. Thomas J. Harris, 104 E. 40th St., New York.

Place: Westchester Country Club, Rye, N. Y. Time: May 30-31, 1940.

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\* Secretaries of societies are requested to furnish the information necessary to keep this list up to date.

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